TRANSLATION

BIOLOGICAL RADIO COMMUNICATIONS

By

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FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

WRIGHT-PATTERSON AIR FORCE BASE

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BIOLOGICAL RADIO COMMUNICATIONS

BY: B. B. Kazhanskiy

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This book is devoted to an examination of a highly interesting problem in modern science: the nature and essence of certain phenomena of electromagnetic communication between living organisms. This subject does not get much attention in world literature, and it is the object of heated arguments and discussions but no common point of view has as yet developed in this area.

The material outlined in this book ranges from the experiments in mental suggestions to animals, then to people, to the idea of creating a "thought register," an "electronic hypnotizer" and "thought transference over distances."

As a bold excursion into tomorrow and a good object of conversation with young people, this book is of great cognitive importance. It is written in popular language designed for mass readership.

The problem of signal transmission by living organisms over distances without the use of the organs of sound, vision and olfaction is one of the most complicated and knotty problems of modern biology and science in general. The subject under discussion is the so-called telepathy, mental information (according to B. B. Kazhinskiy) or, in plain language, the possibility of thought transference over distances.

Many scientists are inclined to believe, on the basis of numerous recent observations and experiments, that the transference of strong emotions, experiences, ideas about the forms of objects and even elementary concrete assignments over distances is quite feasible. But all too frequently, such transference is observed when a person is in distress, particularly in circumstances of mortal danger.

Normally our concepts are associated with the range of our immediate perceptions (or perceptions made possible by the use of various aids) of time and space which are by themselves infinite. Our possibilities in this respect are therefore limitied. Reality undoubtedly extends far and wide beyond the framework of our perception.

There are naturally numerous phenomena all around us which either remain unidentified or about which we know only indirectly, through actual contact with some of their aspects. Telepathy is obviously one of such phenomena. This is probably why the scientists have unfortunately not yet reached a unanimous opinion about the possibility of transferring such a type of information.

Without denying in principle the reality of such a phenomenon, that is the transfer of this type of information (which represents, as was already mentioned, an entirely new quality still unknown to science) by one individual to another over a long distance, we still find it difficult to understand that the material substrate, the carrier of "telepathema", is an electromagnetic field.

In his book, B. B. Kazhinskiy frequently mentions the existence of formations in the cells and organs similar to the elements of a radio scheme. Indeed, such formations are actually described by numerous researchers, and their existence in and outside the cells is no longer denied, even though their function still remains unknown. One thing is certain: whatever the functional direction of such formations (in particular, intracellular, pericellular, etc.), the electrical processes accompanying the numerous functions of the organisms--the biological currents of the brain, heart and muscles, the ionic changes, etc.,--cannot but help produce various types of electrical oscillations in them. The processes that should (!) occur in them in a field of changing electrical potentials are similar to those occurring in a radio transmission or receiving device, that is changing capacity and induction as well as the general of radio waves. This is all the more probable since the mentioned processes are characterized by a definite periodicity, that is they are continuous in nature. It is also difficult to imagine that such processes are not used by the organism as the result of evolution and that the mentioned electrical changes are merely "production waste", an unused byproduct of the major physiological functions. Nature would hardly have produced such "waste" in such an easy and "slipshod" manner.

However, taking into account the low intensity of these radio signals, it is doubtful whether they could serve as a method of transferring mental information. Arguing against this point of view, are the experiments carried out by the American scientists. They experimented in the transmission of a "telepathema" over long distances and from great depths, without any additional devices, directly from one person to another from a submarine completely inclosed in steel. The huge body of water and the metal hull of the submarine were to screen the incoming weak signals and prevent them from reaching the recipient subject. It should be pointed out that a number of researchers insist that in some cases the metal barriers do not block the passage of mental information signals.

The weakness of such signals is one of the greatest causes of all the doubts. The calculations made by V. Arkad'yev show that the bio-radio signals are so weak that a "telepathema" could hardly extend beyond the cranium. It is therefore difficult, and perhaps impossible, to imagine that the radio waves originating in various biological processes in the organism are the material carrier of biological communication over distances of hundreds and thousands of kilometers.

Even if we were to assume that such a weak signal could still overcome great distances, the atmospheric interferences which are dozens if not hundreds and thousands of times stronger than the useful signal would inevitably prevent the reception or perception of that signal by the recipient.

But there are circumstances that tend to refute such doubts. It is a known fact that the different filters used in radio engineering are capable of separating the incoming signals from interferences which are even stronger than the signal itself. Such filters are particularly effective in the field of ultrashort waves (and in the opinion of a number of researchers, the waves originating in the brain are within that range) which are not very much affected by interferences.

We have no reason to believe that such natural "filters" could not have developed in a living organism over the ages even though such an assumption still fails to prove the possibility of transferring mental information over hundreds and thousands of kilometers in view of the fact that ultra waves propagate within the range of visibility.

Even if we assume that in our nervous system the processes of reception and amplification occur at a molecular level or even at a cell level (conditionally identifying them with amplification cascades), which is in principle possible, it is actually difficult to find the range of possible amplification in such a system of weak primary signals in view of the enormous quantity of nerve elements in the brain (over 10 billion). It is also quite possible that a certain type of "radio device" produced in the course of evolution within the organism of animals and

men facilitated the development of a unique method of communication, biological radio communication.

To what extent these assumptions and hypotheses are justified, only the future will tell. Time will probably shed some light on this very vague problem as to whether the material carrier of information is a field, waves or particles. Whatever the case may be, the vagueness and doubts surrounding this question should not induce science to wave the entire problem aside. The existence of this form of biological communication is confirmed by numerous researchers. And the fact that not all the experiments and observations bear out the existence of such a communication still proves nothing.

It is a known fact that in the study of a biological object or a biological pattern, an alternative principle is frequently inapplicable, at least at the present level of our knowledge.

Prudent caution in this connection is, in our opinion, in order and it can be justified primarily in the selection and evaluation of the methods of proving the existence of a new type of information. It should be borne in mind, for example, that the person transmitting the information is not free of his convictions (on the contrary, he acts in accordance with them) resulting from his previous individual experience, which, to some extent, may correspond to the experience and thinking process of the recipient subject (after all, the individual experience is part of the collective experience, and vice versa). As a result, the recipient may in some cases, repeat the same thing as the inductor, independently of him.

One of the decisive conditions or criteria for the evaluation of the authenticity of the preliminary deductions and conclusions made by man in regard to a particular phenomenon or fact is their repeated occurrence as well as the possibility of recording them repeatedly for the purpose of a systematic study and summation of the observations. This is particularly important in this case as we do not know what actually occurs in the course of transmission, what makes it

possible or what interferes with it; nor do we have any instrument for the objective recording of the phenomena of this type of biological communication.

The chief method of analyzing observations in telephathy is the processing of the data obtained through variation statistics on the basis of the theory of probability. We have no reason to doubt the authenticity and correctness of the probability theory, but it is possible that an analysis of the phenomena of biological communication may require other methods of objective analysis.

The process of thought transference is without a doubt associated with material processes in our surrounding medium. An understanding of the nature of these processes and their correct interpretation calls for a very broad study of the problem. Now that practically every day brings us new remarkable discoveries and the phycisists learn about enormous quantities of new "elementary" particles with still unknown functions, we are fully justified in the assumption that the unknown functions performed by these particles include also the function of thought transference.

In all probability, mental information (or, as we would rather call it, a special form of biological communication) originated at an early stage in the development of the animal kingdom and is now dying away, particularly in the case of man, in view of the development of better and more effective forms of communication under the impact of natural and social factors.

This type of communication could have developed particularly under conditions of a sparse distribution of biological objects over a vast territory where the usual visual, auditory and olfactory forms of communication were ineffective as they could not help one creature find another one. On the other hand, this type of information began to lose its significance when biological specimens were found in large concentrations, as well as for other reasons, in the process of evolution. It seems to us that if this function did not die away under conditions of great concentrations of living organisms, the bio-radio transmissions would involuntarily be intercepted by other creatures, and the resulting disorientation would prevent

them from effectuating communication by other means. Thus the development of a second signal system--oral communication among men and combinations of sound signals among animals--is apparently displacing, and in many cases has already displaced, this type of information. In other words, this function is dying away and displaced by other distant sense organs in proportion as the cerebral cortex develops in the general evolution of the animal kingdom. Possible support for this assumption is found in the fact that the weakening of the inhibitory function in the cerebral cortex of mental patients and people in a state of hypnosis intensifies their capacity for thought transference. If the fatigability of the centrums plays an important part in the genesis of hypnosis, it is quite natural that such fatigue should first appear in the cerebral cortex.

In this connection, we should like to point out the following: one of the most widespread symptoms of psychic disorders in mental patients is the feeling that someone on the outside exerts a hypnotic influence on them. It is not impossible that the old capacity for perceiving mental information, no longer controlled by the higher departments of the cerebral cortex, "is awakened" in the patient by the weakened functions of the cerebral cortex and he begins to receive incoming signals which in healthy individuals are filtered out in the cortex before they reach the sphere of consciousness.

Biological communication of the telepathic type in people may emerge from under the evolutionary incrustations of the higher sections of the brain primarily in cases associated with stress and painful experiences when the individual functions are out of the control of the corresponding compartments of the cerebral cortex. There is a certain amount of verisimilitude in such an assumption as the information is received subconsciously, the person does not sense it and it appears to him that he does everything on his own volition without suspecting the external influence of an "inductor". We are familiar with such subconscious signal reception from the famous experiment with infrasound carried out by Wood.

It is characteristic that not a single legible phrase has yet been transmitted in any of the experiments. This is another indirect indication that we have "inherited" the phenomenon of biological communication from the animals which have no concept of any logical sequence of words much less phrases or details of a particular subject. It is probably not accidental that in most cases we perceive the biological effect over a distance as a premonition concerning someone close to us or a foreboding of some event. The information is probably transmitted at a level of the first signal system or such senses as fear, a sense of danger, etc. It is quite natural therefore that the capacity for information transmission first reached its highest development among insects and other representatives of the lower animal kingdom.

As was pointed out earlier, such a form of biological communication is at present most probably an anachronism. But this does not necessarily mean that it is no longer of any interest to science. A profound study of this phenomenon will help us ascertain its physical nature and place it in the service of mankind.

A few words about the author. Bernard Bernardovich Kazhinskiy is an electrical engineer, a candidate of physico-mathematical sciences, a man of great erudition and with an unquenchable desire to understand everything and explain everything. B. B. Kazhinskiy is pioneering the scientific exploration of this problem in our country. In his rich, bold and creative life he has come in contact with numerous outstanding scientists where he often found understanding and support for his ideas. He worked in close communication and cooperation with K.E. Tsiolkovskiy, V. M. Bekhterev, A. V. Leontovich, P. P. Lazarev, and the famous animal trainer V. L. Durov, and was familiar with the science fiction writer A. R. Belyayev, etc. B. B. Kazhinskiy is one of the heroes, Kachinskiy, in A. R. Belyayev's popular science fiction novel, The Ruler of the World. B. B. Kazhinskiy's ideas on biological radio communication as well as his understanding and observations serve as the basic scientific material for this publication.

B. B. Kazhinskiy's book is a kind of history of investigations into telepathy carried out in our country in the past 40 years. In this book the author has

collected a large quantity of interesting data, statements by scientists and his own observations, and processed the entire material in the attempt to provide a theoretical justification for the phenomenon of telepathy. But in our opinion, the solution of this problem by the author is not quite satisfactory. B. B. Kazhinskiy attributes everything, one-sidedly, to electromagnetic processes describing and treating everything from that point of view, whereas, as has already been pointed out, the problem may prove to be considerably more complicated.

Describing a number of formations, organs and their functions, which are in effect still unknown and inexplicable, the author frequently makes unjustifiable analogies attempting to explain them not by scientific facts but on the basis of speculative and hasty conclusions and deductions. For example, the author's assumption about the emission of rays by the eyes and the functions of the epiphysis are highly hypothetical. Besides, it is hardly possible to explain such a complex phenomenon as memory by hysteresis, as the author does. The presentation of Penfield's interesting observations is not sufficiently tied in with the text.

B. B. Kazhinskiy's book is well written and imaginative (in the style of a memoir) and represents a definite value not only from the point of view of the history of the problem, but also because it is one of the first attempts in our country to provide a scientific ground for this problem.

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Candidate of Medical Sciences

Dedicated to the shining memory of my teacher and mentor, member of the academy of sciences of the Ukrainian SSR, Pro. Aleksandr Vasil'yevich Leontovich.

Author's Preface

The investigations submitted to the readers' attention are devoted to one of the truly phenomenal occurrences in nature, the capacity of man to transfer mental information or mentally influence another man at a distance.

This phenomenon was called biological radio communication, but generally it has long been known as telepathy. It was not very long ago that scientists reacted with irritation and even hostility to this word. The point is that to many people the idea of biological radio communication appeared absurd and antiscientific, and the person devoting himself to an investigation of that problem was considered quite hopeless from a scientific point of view. Such a person could not expect any sympathy, much less support.

Fortunately, all this has now receded into the past. Today the idea of biological radio communication is no longer as odd and unattractive as before; it is entering the field of science as a rich and highly promising new discipline, with physicists, biologists, physiologists and chemists ready to further its development. From a phenomenon frightening people off by its uniqueness and novelty, telepathy is gradually developing into an object of increasing attention on the part of the researchers.

True, even now the very idea of thought transference over distances appears to be unreal to some scientists. This, of course, is due to the fact that the subject of biological radio communication has not been popularized by the press. This theme has not been subject to the open creative disputes and discussion that would encourage a further development of the idea and its popularization among the broad masses of the Soviet people.

It is the purpose of this book to fill that gap and to dissipate the remaining scepticism and distrust toward biological radio communication still held by

some people by proving, on the basis of numerous experimental data and observations, the indisputable reality of the phenomenon of mental influence that can be exerted over distances and its rightful place as an object of scientific study.

In this book the author made use primarily of experimental data as well as a number of facts he has personally encountered throughout the many years of his scientific-research work. A considerable part of this material deals with investigations which have already been partially published; the still unpublished investigations were recorded in protocols of scientific conferences, in personal correspondence or public appearances, lectures and conversations. Examples cited from other sources are used to the extent that they confirm the correctness of the authors's theses.

Investigations in this area were initiated back in 1919. Forty-two years have elapsed since the author developed and publicized his hypothesis of the existence of "ganglions" or "apparatuses" in the central nervous system which are similar to the known electrical systems in structure and purpose: simple current generators, condensers, amplifiers, radio transmitting and receiving devices, etc. That hypothesis, in turn, was based on the assumption that the human thought process is accompanied by phenomena of an electromagnetic nature, that is the emission of electromagnetic waves of a biological origin capable of being transmitted and producing producing an influence over long distances.

Three years later (1922), following a number of experiments in the department of physics of the Timiryazev Agricultural Academy in Moscow, the author succeeded in finding in isolated preparations of an animal's nervous system certain nerve elements structurally resembling solenoid loops and paired capacitor plates similar to the well-known elements of the closed Thompson oscillation circuit, a vibrator of discrete currents and eletromagnetic waves.

To verify the correctness of his deductions from that discovery, the author constructed a chamber (for the first time in the practice of physiological research) designed to block the passage of electromagnetic waves, a so-called Faraday cell for experimental purposes. The experiments carried out with that device fully

confirmed the author's assumptions and heightened his belief in the electromagnetic nature of the processes accompanying the thinking process.

A further study of the physical characteristics of the organ of hearing, from the point of view of the nascent theory of biological radio communications, made it possible (in 1943) to adopt an entirely new viewpoint on that organ as an analyzer of a heretofore unknown stimulant reaching the brain, a bio-electromagnetic wave of accoustical frequency.

An investigation of the structure of the organ of hearing in the light of the new experimental data suggested (in 1952) a working hypothesis: the eye not only "sees" but also emits into space electromagnetic waves of a certain frequency capable of producing an effect over a distance on a human being (and on animals in general) on whom the gaze is focused. These waves can influence his behavior, induce him to do certain things and generate various emotions, images and thoughts in his mind. Such an emission of electromagnetic waves of a certain frequency by the eye is called a bio-radiation "ray of vision".

A thorough study of the emotional effect of the "ray of vision" on the behavior of V. L. Durov's test animals enabled the author to decipher and elaborate (in 1953) the somewhat vague assumptions made by V. L. Durov back in 1924: the animals have an inherent capacity to understand each other's behavior. That capacity, according to V. L. Durov, is developed in animals to such an extent that in some measure takes the place of their tongue and speech. It is the author's opinion, however, that this capacity is based on two factors. The first and well-known factor (based on Pavlov's conditioned reflexes) is the visual and auditory perception and "reflex" understanding by one animal of the behavior of another animal (or man). Another factor, heretofore unknown in science, is the concommitant interception by the nervous system of one animal, and the conscious (or subconscious) analysis and synthesis in its brain, of the stimulating signals in the form of bio-radiation waves emitted by the organism of another animal (or man).

These signals are most frequently transmitted by means of a bio-radiation "ray of vision". Consequently, even in the case of animals, there is a reason for

considering both of these factors which I. P. Pavlov referred to in the case of man as signal of signals, that is the second signal system. On the basis of the above-said, the author introduces a new concept, the second signal system in animals. As for the human mind endowed with the higher capacity of a soundless and invisible bio-radiation communication, that capacity, in the author's opinion, represents the third signal system of man.

In about 1933 the author of this book told of his investigations and conclusions to Konstantin Eduardovich Tsiolkovskiy, an outstanding scientist of our country, who listened with a great deal of enthusiasm. K. E. Tsiolkovskiy pointed out that the theory of biological radio communication "may lead to the revelation of the sacred mysteries of the living microcosm, to the solution of the great riddle of thinking matter".

There have been notable advances in this field in the past three decades. Now that experiments in the USSR and abroad have proved the possibility of transmitting preconceived mental information over distances as well as the electromagnetic and bio-radiation nature of this phenomenon and, finally, that we encounter incidents of thought transference in daily life with increasing frequency, the assertion that this phenomenon is supernatural sounds archaic. The more we study the nature of these phenomena the sooner will the cloak of mystery disappear and the problem itself will take its place in the field of exact sciences.

This is what the great Russian scientist D. I. Mendeleyev wrote in 1875 about such phenomena (mostly of a mediumistic nature)[1]: "They should not be ignored but thoroughly examined, that is we must find out which of their aspects can be explained by known natural phenomena and which of their characteristics are fabrications and hallucinations and shameful frauds and, finally, we must ascertain whether some of them belong to a category of still unexplainable phenomena governed by still unknown laws of nature. After such an examination, these phenomena will lose their aura of mystery, to which so many subscribe, and there will be no room for mysticism."

The gist of D. I. Mendeleyev's statement, of course, applies fully also to the phenomena of telepathy. Psychology as a science should look into the telepathic capacities of the brain along with the instinct, consciousness and thought-- something it has so far failed to do by shying away from any bold and decisive venture into the new and vast unexplored area of knowledge dealing with these characteristics of the human psyche.

What are thought, consciousness, sensation? "Sensation is a direct connection between consciousness and the external world, a conversion of the energy of external stimulants to a fact of consciousness. This conversion is observed by every person millions of times at every step", V. I. Lenin wrote in his Materialism and Empiriocriticism (V. I. Lenin, Works, Vol. 14, p. 39). He also emphasized that thought and matter are "actual", that is they exist, and that the brain is material and thought is nonmaterial.

Thought is nonmaterial, it is a product of material processes accompanying the thinking process. What is transmitted over a distance is not the thought, resulting from the activity of the cerebral cortex, but the electromagnetic and radiation waves which, according to the theory of biological radio communication, are emitted outward by the brain during the process of thinking when electric impulse currents pass through the cerebral ends of the analyzer (as an active part of the oscillation circuit of the nerve chains). The incoming bio-electromagnetic and bio-radiation waves (a product of the thinking process of the first man) carry the energy of an external stimulant in the form of consciousness to the brain of the other man.

Consequently, to the entire volume of psychic operations of the brain, already known in science as the total of the higher natural psychic functions of the brain cells, we must add a new and heretofore unknown higher psychic function consisting in the capacity of transferring and intercepting the bio-electromagnetic and bio-radiation waves accompanying every thought process. Representing a physical phenomenon, the electromagnetic and radiation waves emitted by the brain of one man in the process of thinking, reach over distances into the nerve cells of the brain

of another man stimulating the operation of the second brain: the thinking process initiated in this brain is in every way similar to the thinking of the first brain. And this represents the third signal system of man.

Following the example of P. I. Gulyayev, Doctor of Biological Sciences, the author refers to the bio-electromagnetic and radiation wave as telepathema finding it to be a very appropriate name. However, the term "telepathy" (inasmuch as it is associated with the wrong and distorted interpretation of the phenomena of thought transference over distances) should be expressed by a new term, such as "biological radio communication", for example, which offers a clearer depiction of the natural capacity of man (and animals) to intercept mental information and sensations (through a physical medium) as one of the brain functions performed by the nerve cells, the biophysical apparatuses.

FOOTNOTES

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1	(See the "Proposals" of D. I. Mendeleyev to the Physical Society of the Petersburg University on the establishment of a commission for the investigation of phenomena referred to as mediumistic, May 6, 1875.)	12

CHAPTER I

A CLEAR CASE OF BIOLOGICAL RADIO COMMUNICATION

It happened in the last days of a sunny August of 1919 in Tbilisi. My friend M., a youth of 19, had been ill with typhoid fever for several weeks. He was confined to bed at home, and I went to visit him every day after work.

Returning home from a visit to the patient one night (I lived about one kilometer from M's apartment), I went to bed and, as usual, was soon fast asleep. In the middle of the night I quite clearly (I would say quite materially) heard a sound: it was a fairly loud metallic sound like a silver spoon striking against a drinking glass.

I awoke immediately and thought that the cat had apparently upset some of the tea dishes on the writing table. Propped on my elbow I turned on the light and looked at the desk. There were no dishes on the desk, nor was the cat in the room. Looking at my watch (it was exactly 2 a.m.), I turned off the light and fell asleep again.

The next day I went straight from work to the patient. Strangely enough, as I was approaching M's house I was gripped by a vague feeling of alarm. That was the first time it happened to me.

Coming up to the front entrance, I immediately saw that something unusual had happened in the house. Everything looked strange. The door facing the street was wide open. With bated breath I rushed into the apartment...My young friend was lying dead...Standing near him was his bereaved mother and some other women dressed in mourning.

Helping to carry the body from the bed, my foot accidently caught on the night table near the bed, and suddenly I heard the same silvery sound as the one that had awakened me on the previous night. I felt a strange sensation which I could not explain. Looking at the night table with an unaccountable feeling of apprehension I noticed a saucer, a drinking glass with a silver spoon. Without thinking I picked up the spoon and tapped lightly against the glass. The familiar sound came to me

again. "But how could I hear that sound at home at night?", I kept thinking instead of helping the grieving old people or trying to console them in some way. But the persistent thought of the "material nature" of the sound I had heard at night just would not leave me.

Confiding the story in brief to M's mother, I asked her to tell me some details she may have noticed at the time of her son's death. "It was exactly at 2 a.m.", M's mother said. "Following the doctor's prescription, I gave the medicine at that time ladling it out from the glass with a spoon. But as I brought the spoon up to his lips I saw that the luster of his eyes grew dimmer. He did not take the medicine. He was dead."

There was an oppressive silence. The reader can easily imagine how I felt, facing the mother whose beloved son had just died in her arms. Any unnecessary word or remark could heighten her suffering. But I kept interrogating her, like an inquisitor, compelling her to reach deeper into her memory. Conscious of all that, I still could not and had no right to act in any other way. I again asked her to show me how she took the medicine out of the glass with the spoon.

Her hand shaking, M's mother reached into the glass with the spoon for the medicine. And again, for the fourth time, I heard the same clear silvery sound I had heard the previous night!

I am not superstitious, but at that moment I felt a cold shiver run down my back: I realized that today, near the still warm body of my dead friend, a mysterious act of a man reaching the threshold of a new great truth of nature had occurred. There was no longer any doubt in my mind that this very sound I had heard at night and the sound of the teaspoon on that night table near the bed of my dead friend were the same sound.

I was gripped by a passionate and irresistible desire to try and solve the mysterious meaning of that phenomenon. This idea never left me for a single moment since that memorable day. I constantly thought of different analogies and all sorts of assumptions but for a long time was unable to find an answer to the main question:

how could I intercept the "transmission" of the silvery sound from a distance?

The idea of a possible common analogy between ordinary radio transmission and the transmission of sensations over distances occurred to me and looked promising, but this problem required a deeper knowledge of the rapidly developing radio engineering, particularly radio-transmission and reception devices, as well as human physiology. I had to find in the human organism the elements that were structurally and functionally similar to the basic components of a transmitting and receiving radio station. In short, I had to make a thorough study of the nervous system.

Searching for Analogies

Going deeper into the history of radio engineering, I began to trace in minute detail Aleksandr Stepanovich Popov's device called the "Thunderstorm Marker". As is known, that device (Fig. 1) consists of a coherer AB and a relay CD. The relay is designed to close the electric bell circuit GH. When the resistance of the metal powder in the coherer drops under the effect of electromagnetic waves, the current of battery P activates the relay GD. The electromagnet C attracts the reed D which closes the contact E. This closes the GH bell circuit. When the reed H is attracted to the electromagent G, the bell begins to ring. In its back swing the bell hammer hits the coherer tube AB, restoring the resistance of the metal powder in the coherer and opening the bell circuit until the next round. When the coherer resistance drops again, under the effect of the electromagnetic waves (coming from the outside), the current of battery P activates the relay CD and the whole cycle of operations is repeated.

The device registers the electromagnetic waves coming to the outside.

Something similar, in my opinion, is observable in the transmissions of mental information from man to man over a distance.

This deep conviction of mine could not be shaken even by the statement of the brilliant scientist A. S. Popov to the effect that the human organism had no such organ of sensing electromagnetic waves in the ether; if an instrument were invented

that could replace our electromagnetic sensations, it could be used for transmitting signals over a distance.

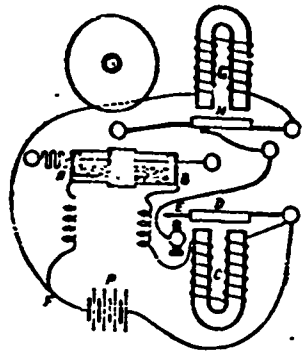

Fig. 1. Diagram of the first radio receiver in the world invented by A. S. Popov who called a "thunderstorm marker".

On the contrary, A. S. Popov's reasoning convinced me that I had selected the right method of investigation. What I saw in it was not a denial of the existence of such an organ of senses in us but rather an impelling urge to look for it. Again and again I directed my attention to the basic elements of a radio receiver and transmitter. The "radio conductor", or coherer, appearing in the diagram of A. S. Popov's radio receiver, attracted particular attention. The coherer was invented by the physicist E. Branly. Branly discovered the polarization of tiny metal particles (iron shavings) when electromagnetic waves are passed through them, and called this phenomenon "radio conduction" [14]. In this case, according to Branly, iron particles are arranged in a continuous "contact chain" under the effect of the electromagnetic waves (just like iron shavings are arranged along the magnetic lines at the poles of a strong magnet). Permeated with an electromagnetic wave, such a "contact chain" of particles becomes a good conductor of electric current fed to it from an outside source.

A more plausible explanation of this phenomenon is, in my opinion, provided by the English physicist O. Lodge [50]: under the effect of electromagnetic waves penetrating the medium containing the iron shavings (the coherer tube), the

microscopic air gap between each pair of adjacent shavings is destroyed, as a dielectric, by the scintillations forming something like current conducting "bridges" between the adjacent particles; this accounts for the drop in the resistance at the coherer contacts. The strong vibrations set up by the bell hammer strikes on the coherer disrupts these "bridges" and restores the normal resistance. O. Lodge introduced the term "coherer".

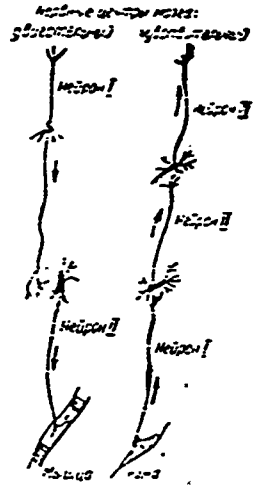

Fig. 2. Structural diagram of the neural tracts.

But Dr. Branly was wrong in another and more important respect. He believed that there was an analogy between the phenomenon of "radio conduction" and the conductivity of the neural impulses in the nervous system. He subscribed to the opinion, currently held at that time, that the structure of the nervous conductive path (Fig. 2) consists of anatomically separated units, neurons.

According to the theory based on this scheme, the internal fibers (neural fibrills) of one neuron conducting the nervous current (impulse) do not change into the neurofibrillar filum of another neuron. But the terminal ramifications of the adjacent neurons are merely contiguous with each other. Contact at the boundary of two adjacent links of the neuron chain is achieved by gluing the neural plasma of the nerve ends. Thus the neural fibrillar apparatus of each chain link (each

neuron) appears to be electrically insulated from a similar adjacent link.

Drawing a parallel between the passage of the neural impulses in the nervous system and the passage of an electric current through a "radio conductor", Branly advanced the hypothesis of the functional identity of a neuron and iron particle of a "radio conductor": just like a "radio conductor" is made inoperative by a mechanical break in the contact between two adjacent iron shavings in the coherer (when the contact in the chain of iron shavings is borken), the passage of the neural impulse from one neuron to another, when the contacts between the ends of the adjacent neurons are not tight enough or are broken.

The idea of such an identity, as it turned out, had a substantial shortcoming. The point is that the contact between two adjacent neuron ends could be disrupted only by a traumatic injury to the nerves. Referring to Branly's hypothesis, a Russian woman doctor A. I. Bobrova [13] writes that such a break in the contracts would cause anesthesia and a hysterical paralysis which, in effect, means an unnatural condition of the nervous system. Obviously, we must consider the operation of the nerves in their natural condition.

This inconsistency of Branly's views makes his analyses valueless. This is what professor A. V. Leontovich, an experienced experimenter in the physiology of nerves, says in his book The Physiology of Domestic Animals: "It was only recently that a great popularity was enjoyed by the theory according to which the dendrites (branchy neuron ends--B.K.) are capable of motion, and these movements were used 'histologically' to explain practically every physiological and psychological phenomenon: sleep, narcosis, memory, habit and exercise results, attention, etc. Experiments have unfortunately failed to confirm the changes in the position of the dendrites".

Academician V. M. Bekhterev's theory takes an entirely different view of the passage of the neural impulse from one neuron to another: "The contiguous parts of the neurons are something like condenser armatures, and when an electric "neural current" adheres to one armature, that is to one dendrite or pericellular apparatus,

a reverse 'neural current' usually appears on the contiguous dendrites or cells, and the usual current direction is therefore retained on the dendrites of the two neighboring cells" [44].

Academician V. M. Bekhterev obviously set himself the task of explaining only the electrical passability of the neural impulse through the contact, even though he left out of account the nature of the electrical phenomenon which make it possible for the neural "action current" to pass through that contact-condenser. But still V.M. Bekhterev's statement gave me a clue to the method of approaching the solution of the problem I was facing. Using this as a reference point, I conceived the clear and simple idea (in December 1919) that if a diagram of a particular closed neural path (Fig. 3), containing facings of condenser D and, of course, a source of "action current", were to include (through a condenser connection) the loops of solenoid Q to produce a self-inductance in that scheme, the result would be a biological oscillation circuit in which the biological electromagnetic oscillations are accompanied by the emission of electromagnetic waves of a biological origin.

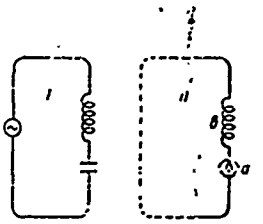

Fig. 3. Diagram of the Thomson (closed) oscillation circuit.

1 - acutal radio circuit
2 - "biological" circuit

This will represent (with some modifications, of course), the natural organ inherent in our central nervous system including the cerebral cortex and capable of emitting and, as A. S. Popov stated, "Perceiving electromagnetic waves in the ether".

The reader will now have a chance to see for himself whether this conclusion is scientifically well grounded. Can any proof of it be found in animate nature?

The Nervous System and Radio Engineering

Plunging into the study of the structure of the human nervous system in 1919, I was looking primarily for an answer to the question of how I could hear the silvery sound-- that sound sensation I had intercepted from a remote source, the nervous system of my dying friend. I quite naturally began by studying the minutest structural details of the human auditory neural apparatus. My elder brother, Dr. Kazimir Bernardovich Kazhinskiy, an ear, throat and nose specialist, helped me in my initial studies of the anatomy of the organ of hearing. It was through him that I also became acquainted with the remarkable works of the professors I. M. Sechenov, V. M. Bekhterev, N. E. Vvedenskiy, A. A. Ukhtomskiy, V. Yu. Chagovets, A. V. Leontovich, etc., especially in the field of electrophysiology.

The books my brother gave me included the interesting work of the French physician Mallard [51] and the already mentioned "Textbook of the Physiology of Domestic Animals" by A. V. Leontovich. His book contained an almost complete account of the experiments on the effect of an electric current on the tissues of the organism, and convincing proof of the presence of electric processes in a living organism. The study of that material broadened my knowledge of the physiology of nerves a great deal and facilitated the problem of drawing an analogy between the natural purpose of the individual elements of the nervous system and the possible function of these elements as parts of a biological radio communication apparatus.

We will now discuss these analogies. According to A. V. Leontovich's interpretation, there are two types of nervous systems, neural and nonneural ("Remakov"). The first of them is made up of special units, neurons. The ganglionic cell 1 (Fig. 4) usually lies in the brain (or spinal cord), and together with its dendrites

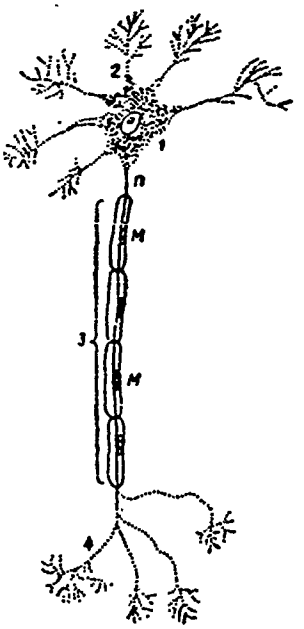

Fig. 4. Structural diagram of a neuron
(according to Leontovich)

1 - central link of "ganglionic cell" neuron (Nissl granules are visible inside cell soma);
2 - protoplasmic branches, or dendrites;
3 - the middle portion of a neuron consisting of a neurite enclosed in membranes M which are divided into segments;
4 - telodendrons; n - nerve stem or neurite (forming the "axial cylinder" of the nerve which is called axon).

(branches) 2 is included in the gray matter of the brain. The neurite n, branching off from the ganglionic cell, plays the part of a conductor of neural impulses. A considerable portion of the neurite is inclosed in a muff M consisting of an internal myelin and external Schwann's sheaths. The myelin part of the muff is so called because it consists of a special fatty substance, myelin. The neurites form the

major part of the white brain matter or the peripheral nerves. The telodendrons 4 (from the Greek word "telos" meaning end and "dendron," tree) are either branchy ends of the neurite or resemble a netting or basket weave. The telodendrons end in the muscle, a gland or surround the ganglionic cell of another neuron when these ends are like a netting or basket weave. In the latter case the telodendrons are called pericellular apparatuses, or simply pericellulars.

Wherever the end sections of telodendrons or the pericellular apparatus of one neuron approach the ganglionic cell of another neuron, the protoplasm of the neural fiber of these ends do not simply change to the protoplasma of the ganglionic cell but are separated from it by a borderline surface. In a physical sense, the body of this ganglionic cell is separated from the surrounding ends of the adjacent neuron branches by a membrane. In 1897, the English scientist Sherrington [60] proposed that these protoplasmic contacts be called "synapses."

We can now provide a more contemporary description of the synaptic contact, such as the motor neuron of the spinal cord of a mammal, for example, according to a later source, John Eccles' book [77]. The body (or soma, as it is otherwise known) of the motor neuron measures about 72 spaces across. The dendrites extend from it about 1 mm before they branch out into thin ends. Extending down from the soma is the trunk of the neurite, the axon. It gradually narrows down, and at about 50-102 spaces from the soma the cells are covered with a myelin membrane. The adjacent soma surfaces, irregularly formed circles and ovals (7 of them) with tiny spots inside, are special swellings (synaptic plaques) representing the ends of the telodendrons extending from the contiguous neuron.

In the somatic protoplasma of the ganglionic cell are microscopic bodies, or nissl granules, so-called after the name of the scientist who had studied them.

The other part of the cell soma is of a fibrous structure. The extension of this fibrous portion of the cell that represents its outgrowing neurite in its internal fibrous (fibrillar) part is called the "axial cylinder" or axon.

The work of the nervous system (like any other work) involves an expenditure of energy. The main if not the exclusive source of energy of the neural current is, according to Bekhterev [10], the granular portion of the somatic protoplasm of the ganglionic cell. Every excitation of the nerve leaves a definite trace in the ganglionic cell. A persistent and lengthy excitation in the soma of the cell, on the other hand, reduces the quantity of the nissl granules. As it is being used up, the neural energy is restored by the inflow of nutritive material from the blood circulation. This is what A.V. Leontovich [45] writes about it: "All the smaller blood vessels of the brain are apparently inclosed in very delicate tubes, so-called perivascular spaces, which do not consist of the ordinary lymph but of a so-called cerebrospinal fluid very rich in water. Similar lymphatic spaces apparently also appear in the peripheral nerves beginning with the brain spaces beneath the dura mater. Thus it appears that the neural elements get their nutricion not directly from the blood but through the cerebrospinal fluid."

Figure 5 shows a diagram of the sensitive and motor tracts, according to Ramon-y-Cajal. The neural impulses (perception, sensation, excitation, etc.) follow the sensitive tract from the human skin and muscles to the cortex, that is from the periphery to the center (as indicated by arrows pointing to the brain). The sensitive tract is therefore also called the centripetal tract. There is also a motor tract which the neural impulses (volitional brain commands, reflexes or responses to irritation, etc.) follow from the brain to the skin and muscles, that is from the center to the periphery (as indicated by arrows pointing away from the brain). The motor tract is therefore also called a centrifugal tract.

Through the instrumentality of the centripetal tract, our brain "analyzes" the impressions received from the outside world. The commands of the brain and responses (reflexes) of the central nervous system are transmitted to the outside world by the centrifugal tract.

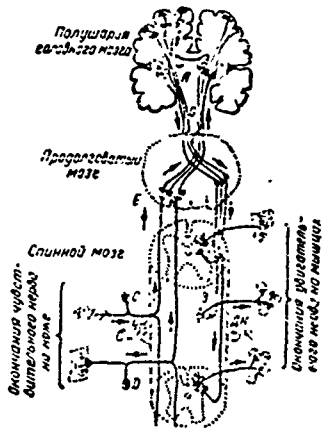

Fig. 5. Location of sensitive and motor neural tracts (according to Ramon-y-Cajal)

A - pyramidal tract running from the motor cells of the cortex;
C & D - sensitive cells of the ganglion invertebrale;
ChK - sensitive nervorum spinalium;
B - motor cells of the naterior spinal cord crescents adjoining the telodendrons of the pyramidal cell;
DK - motor cells in the medulla oblongata. Arrows indicate direction of neural impulse movement.

We have now come to the problem of the possibility of the nervous system emitting electromagnetic waves. First of all, it appears that particular physico-chemical processes are always taking place in our nerves; they are more intensive when the nerves are irritated and less so (or absent altogether) when the nerve is "at rest." It is an established fact that when the nerve is stimulated, the substance contained in the axon fibrills is subjected to a chemical decomposition followed by a restoration when the stimulation is absent. The substance in the nerve fibrills, a very complicated chemical composition, is an electrolyte.

In physics the electrolyte is known as the second type conductor in galvanic elements. When conductors of the first type -- coal and zinc -- are immersed in the electrolyte and their outside ends connected by a metal conductor, the chemical process, the decomposition of the electrolytic substance, sets up an electric current. In other words, the salt solution of the electrolyte posses electrodynamic

properties which remain hidden when there is no current (potential state) and are revealed in the course of the decay process (dynamic state).

The nerve substance, fibrill, contains a certain percent of the salts, that is it represents a unique electrolyte. This explains the possible formation of electric currents in the neurite axon which are referred to as "action currents." These currents accompany the decay process of the neural substance both during artificial irritation or stimulation (as for example in experiments with a nerve preparation isolated from the rest of the nervous system) and during a natural neural impulse, that is when the process occurring in man is what we call the psychic operation of the central nervous system, including the brain.

Here it would be quite important to refer to the authoritative opinion of Academician V.M. Bekhterev describing from an energy point of view the passages of the neural current (impulse) in both tracts of the human nervous system. In his work [10], published posthumously in 1928, he writes: "...We know that neural current is found not only in the peripheral conductors and the spinal cord, which has been known for a long time, but also in the cerebral cortex and, as my laboratory investigations have shown, is accompanied by a negative electric oscillation in the form of action current..., which activates the neural impulses. To explain the passage of the neural current from one neuron to another... I once proposed a theory of categories based on the difference in the potential energy of two neighboring neurons interconnected by a contact...

But how are the brain cells activated, and what accounts for the stimulus that results in the discharge of the reserve energy of the nerve cells? In this case we must bear in mind that all the acceptor apparatuses, as I admitted in my work published in 1896 (Review of Psychiatry, 1896, and Neurolog. Zentralblatt in the same year), should be considered as special transformers designed to convert various forms of external energy to neural current; the latter, flowing to the cerebral cortex through a number of neurons by means of Martinoti cells, associated Ramon-y-Cajal cells and collaterals, reaches the cortical cells which send to the

periphery descending, or centrifugal, but mostly branching, conductors. These conductors, in turn, form a number of neurons which the current follows to the periphery stimulating, in some cases, the contractive muscular tissue (the lined and smooth) thereby converting the nervous energy to mechanical operations; in other cases it produces corresponding changes in the glandular apparatuses. In the latter case, the work is connected with the separation of the chemical product entering the blood (when the ductless glands are involved) or emerging to the outside through excretory ducts or, finally, discharging into the appropriate body cavity. The above-mentioned method produces a complete energy circuit whereby a particular external energy acts upon the external or internal receptors and is transformed into a neural current associated with the ionization process; the latter stimulates the discharge of the reserve cell energy setting up a reverse current connected with the ionization process; extending along the neuron chain, the current reaches the muscles and glandular organs which perform their respective function."

Reviewing the structure of the nerve elements as outlined in the mentioned textbook by A.V. Leontovich [44] from the point of view of biological radio communication, it occurred to me as far back as 1919 that a number of analogies between these nerve elements and the components of radio stations could be drawn. But even in those valuable sections of A.V. Leontovich's book dealing with electrophysiology I was unable to find any indication of the possible phenomenon of self-induction in the spiral windings of the neurite and the specific purpose of these spirals related to it, like "self-induction coils" in a living organism, for example.

Looking for an analogy between the elements of the nervous system and those of a radio station, it became clear to me that the author of the book did not find it possible (at least in those times) to consider the spiral in the nerves as "self-induction coils." This conclusion is also supported by the fact that elsewhere in the same book A.V. Leontovich makes only fleeting reference to the condensor phenomenon in the nervous system, according to V.M. Bekhterev's theory[1]. It may be

pointed out in passing that I also failed to find any indication of an analogy with the oscillations of the Thompson circuit in V.M. Bekhterev's works. Consequently, this problem is entirely new, still unexplored and waiting for me to develop it.

Still more hypothetical are some of my other analogies as for example the nerve corpuscle, called the "Krause bulb" (Fig. 6), which is sensitive to cold. Since these corpuscles are located primarily at the periphery of the nervous system, it may be assumed that their purpose is to intercept the electromagnetic waves coming from the outside, that is to serve as antenna loops.

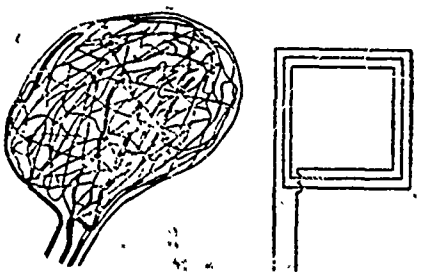

Fig. 6. The sensitive (to cold) neural corpuscle, the "Krause bulb," taken from the skin of a peripheral human organ.

The outer shell of the corpuscle includes nerve fibers with branching ends inside the shell (according to Dogel'). Note the similarity between this corpuscle and the antennal loop shown next to it.

The ganglionic cell (Fig. 7) is a microscopically small nucleus of the intervertebral nerve ganglion of the sensitive tract which lies in the spinal cord. The nucleus is surrounded with an intra-protoplasmic fibrill net with a primary fibrill extending from it to the axial cylinder of the nerve. The nuclear corpuscle is surrounded by another net made of plexiform nerve filum whose two terminal branches extend away from the axial cylinder of the nerve. Such a nerve ganglion, in my opinion, could serve as a detector, amplifier or even generator of electromagnetic oscillations.

Studying the structure of the cardiac nerves in the mentioned book by Dr. Millard [51], I found a resemblance between the ganglionic "bulbs" of the

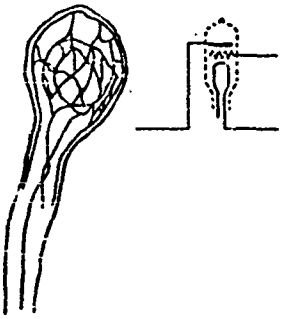

Fig. 7. A ganglionic cell with an intraprotoplasmic net of fibrills and with a "primary fibrill," axial nerve cylinder, and several secondary fibrill branching off from it.

Not the similarity with diagram of a thermoionic triode tube shown next to it.

cardiac nerves (Fig. 8) described in it, and Round's thermoionic tubes as detectors, amplifiers or generators of oscillating currents. A spiral-shaped filum enters the "bulb" from the side, in addition to the main filum, and then branches away from it. In some places the spiral does not wind around the main filum which leads away from the bulb "basket" but merely envelops it here and there. We also find not one spiral but two of them, next to each other. Finally, one also observes a successive connection of several bulbs, one after the other, in the form of a wreath or a peculiarly shaped bunch of grapes. There are no suggestions in Mallard's book about the possible "radio engineering" purposes of these bulbs and their group connections. It seemed to me that such an individual bulb could be assigned the role of a cathode triode detector or degenerator, and their group connection the role of similar triode tubes of cascade amplifiers of bio-electromagnetic waves.

For the initial study of the electromagnetic essence of the phenomenon of thought transference under consideration, I suggested a screening device modeled on the well known Faraday cage. If a man transferring mental information were put into that device, it would block the electromagnetic waves emitted by his central nervous system and prevent them from getting outside through the walls of the

Faraday cage thus insulating them from the possible effect outside the cage.

It was also proposed to construct devices, on the principle of that cage, designed to protect the human central nervous system against the effect of the bio-electromagnetic waves coming from the outside. Should these proposals be borne out by experiment, it would be possible to develop individual cages for everyone desiring to be protected against such external influences by introducing a very thin metal "webbing" into his clothes. Groups of the population and large bodies of people could be protected by installing metal nettings in the outside or inside walls of the buildings. Similar nettings, held within frames, would cover the window and door openings and be connected to the nets in the walls. It is understood also that the edges of the nets would be just as solidly connected with the metal sheets of the roof. The lower edges of the wall nets would be extended downward and grounded.

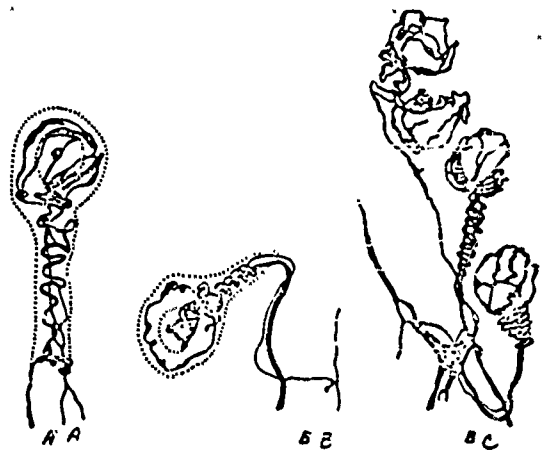

Fig. 8. A ganglionic cell of the cardiac nerves (according to Mallard):

A - a solitary cell resembling a triode radio tube;
B - with spiral winding around the axon, it resembles a solitary triode radio tube;
C - group cells shaped like a bunch of grapes and resembling radio tubes connected in series.

Later in the book we will tell about the results of the experimental verification of my idea.

The First Sallies Into the Open

Looking into the above-listed analogies and developing my schemes, I of course still consider them as a very crude approximation. They may not be quite right, I thought, but given proper publicity[2], they may still prove to be useful material for scientific discussions, or stimulate other researchers to more productive work on such a new problem. The reader will soon see that in some respects my expectations were justified.

My working hypothesis that thought is an electromagnetic wave inevitably attracted a great deal of attention in the technical and medical communities everywhere I spoke about it, particularly after the October Revolution which stimulated in the people a great and [illegible] desire for knowledge. Invited by the engineering community to speak on the mentioned hypothesis, I made a number of reports in 1920-1922 in Tbilisi, Telavi, Mogilev (on the Dniepr) and in Moscow at the All-Russian Congress of the Association of Naturalists. The Congress was held in the large auditorium of the Timiryazev (at that time Petrovsko-Razumovskaya) Agricultural Academy. A special Congress decision adopted after my report made it possible for me to devote myself exclusively to the further development of my hypothesis. The protocol of the Congress (of 16 February 1922) read: "Resolved: Mindful of the value of the speaker's thesis, as a working hypothesis, the Congress finds it necessary to offer Comrade Kazhinskiy all possible cooperation in his proposed research on the mentioned problem, to work at a salary of an Association scientist it also finds it desirable to acquaint the Association and the student body with this report by way of arranging public lectures."

Three days after the report I gave the first lecture under the title "Human Thought: Electricity." The large auditorium was packed by a lively crowd of students. The front rows were occupied by the Academy's professors and teachers. These included professor A.V. Leontovich whom I met for the first time.

At that lecture I demonstrated my ideas of the elements of the nervous system, already familiar to the reader, and my analogies between them and the components of radio stations as well as the schemes of transmitting and receiving human biological radio stations (Fig. 9).

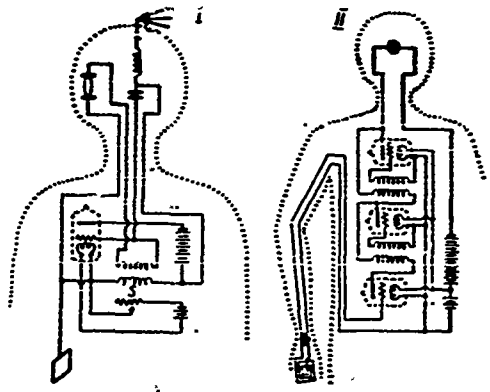

Fig. 9. Initial diagrams of transmitting I and receiving II biological radio stations of the human nervous system

A.V. Leontovich took the floor directly after my speech. Frankly, I felt quite alarmed at the time, not knowing what that AUTHORITATIVE scientist would say. He spoke quietly, convincingly and fairly long. In conclusion he expressed a general opinion on my report. It was quite favorable. My state of alarm gradually gave way to a feeling of relief and even pleasure. Professor A.V. Leontovich was the first to offer a favorable scientific appraisal of my proposals, and in public at that. When he finished, the audience broke out in loud applause which I, in all honesty, attributed to the credit of A.V. Leontovich. I walked up to him, applauding, and we shook hands. We were joined by the chairman of the Naturalist Association, A.P. Modestov, who solemnly congratulated me on my success. By that time we were surrounded by a crowd of young people. Many of them helped me to collect my diagrams and graphs from the walls.

On the way back, I walked with A.V. Leontovich for a considerable part of the way. I told him about myself, my life and work. We parted near his apartment, and he graciously invited me to visit him at home.

Laboratory Experiments

Soon after my lecture, professors A.V. Leontovich and A.P. Modestov made it possible for me to study in the physiological department of the Timiryazev Agricultural Academy where I plunged into the investigation of preparations of animal nerves, studied the histology of most of the nerve elements of interest to me, etc.

We know from physiology that the stimulation impulse travels along the motor nerve at a speed close to 30 meters per second. This figure was confirmed also by our experiments (with a live frog). We also made the following experiment: one of two separately prepared neural motor tracts of a frog together with the nerve muscles (legs) was placed in a salt solution of an electrolyte possessing maximum electric and magnetic properties (under the effect of an artificial electromagnetic field and with the aid of a solenoid surrounding the electrolyte), and the other was placed at the same time in distilled water (that is in a dielectric). The muscle contractions produced in these two preparations by irritating the nerve with a [illegible] current were clearly different from each other both in the strength of the muscle contraction and in the time it took the impulse to travel along the nerve [illegible] in the first case the force of contraction was relatively great and the speed of the impulse was higher than the norm (> 30 meters/sec), and in the second case were below the norm. This led to an important conclusion: the manner and speed of the stimulation impulse passage along the nerve are determined by the electromagnetic properties of the surrounding medium to a marked degree. In other words, the external electromagnetic field surrounding the animal's nervous system produces a marked effect on the performance of the nervous system.

In one experiment carried out in A.V. Leontovich's physiological laboratory photographs were made of the needle deflections of a galvanometer as the nerve was being irritated by induction currents (that is nerve stimulating currents) which showed that the voltage of the nerve's motor force (produced in it by the stimulation impulse) is equal to or even a little greater than 0.001 volt. Such a voltage of the nerve's electromotive force is quite sufficient to reduce to zero the electric resistance of the nerve filum as the "action current" passes through it.

Continuing my investigations, I plunged into a world of ultramicroscopic magnitudes and those close to the threshold of visibility that could be detected only through a powerful microscope. I soon became convinced not only of the existence of spiral windings of the nerve filum representing the "live" solenoids with magnetic properties I had been looking for, but I also realized that it was possible to compare the varicose dilatations (which I called "plaques") at some of the ends of the peripheral nerve branches to two condenser armatures.

In most cases, or I should say in all cases, of pericellular nerve apparatuses, these "plaques" were found to be double, that is two plates arranged next to each other. A close look through the microscope at a preparation dyed with a good methylene blue (a dyeing method specially developed by professor A.V. Leontovich) revealed that a barely visible nerve filum lead to each of these plates. This enabled me to look upon the "plaques" as the windings of a microcondenser connected to the two *HALVES* of a closed Thompson oscillation circuit. In some preparations the nerve filum was helical, and I compared it to a microsolenoid connected through a microcondenser in such an oscillation circuit.

Although I was overjoyed by every such observation, I unfortunately failed to detect any signs of enthusiasm on the face of my supervisor, A.V. Leontovich. I was under the impression that he did not attribute any "electrical" significance to the morphological characteristics of the nerve. But to me these nerve elements appeared as nothing less than "live" solenoids and condensers, the self-induction and capacity apparatuses which make up the long sought for Thompson oscillation circuit in a living nervous system.

But the chairman of the Society of Naturalists, A.P. Modestov, revealed an entirely different attitude when I invited him (in July 1922) to examine these "plaques" and "solenoid" windings on nerve preparations through the microscope. Leaving the microscopic side, A.P. Modestov became highly enthusiastic and, embracing me, announced that this was "a real discovery." He insisted that I immediately write a scientific report on my work for publication. I submitted my report August 1922. Before the manuscript of my future book, Thought Transference, was turned over to the printer, A.P. Modestov wrote an enthusiastic foreword in which he even referred to the term "discovery".

Encouraged by all that, I continued to study the nerve elements of various human organs pursuing the goal of developing an instrument for recording the electromagnetic waves emitted by the central nervous system in the process of thinking. I drew up a basic diagram of such an instrument (Fig. 10). Obsessed by the desire to study the characteristics of radio instruments and tubes in relation to the above scheme, I eventually (from October 1922) began to work as a temporary laboratory technician in the experimental laboratory of the "Radio" electronic instrument plant in Moscow.

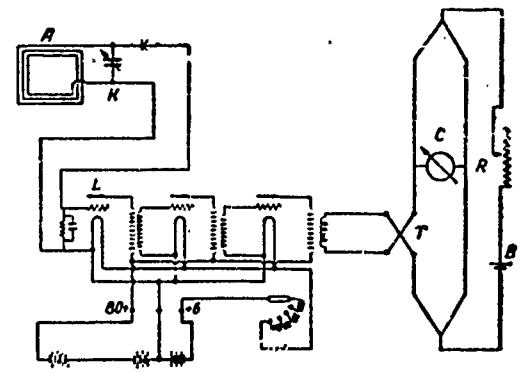

Fig. 10. Initial diagram of an "electromagnetic microscope" for intercepting and recording biological electromagnetic waves emitted in the process of thinking.

The main part of the scheme consisted of a string galvanometer C with a high sensitivity of 10^{-10} amperes, that is one ten billionth part of an ampere. The instrument C indicated the current only when the resistance equilibrium in both halves of the Wheatstone bridge was disrupted. By introducing into the scheme the resistance of a junction of two wires in a vacuum-type thermoelement T and balancing this resistance by a controlled rheostat R, it was possible to have the string of the Galvanometer C occupy a zero (neutral) position between the poles of the instrument's magnet. But as soon as the resistance of the junction in the thermoelement T changed, the equilibrium in the Wheatstone bridge was disrupted and the galvanometer string deflected from zero. By passing a light ray through the microscope eye piece (and changing its lenses), it is possible to fix these string deflections on a screen or a rotating mirror and thus photograph an ordinary or motion picture of the oscillations. It was believed possible to produce oscillating currents in the A-T circuit required for the study of the electromagnetic wave by placing the nerve preparation under investigation (or the head of a thinking individual) in antenna loop A. Becoming condensed in the condenser armatures K, these currents will change the grid potential in radio tube L which, in turn, will change the cylinder and filament potential in that tube. The current from battery B will therefore be changed by the wire connection in thermoelement T, and the resistance of the wire connection in T will also change. Assuming that the currents intercepted at A would be too weak to be reflected in the changing potential in T, I found it necessary to amplify these currents by adding another two (or more) amplifier tubes to circuit A-T. My device was something on the order of an "electromagnetic microscope" designed to detect the disappearing weak electromagnetic waves of a biological origin.

In addition to employing the "electromagnetic microscope" for the study of nerve elements, I thought it possible to use it on a person or animal (preferably an animal, to begin with) in order to acquire the necessary practical habits. Early in August 1922 I consulted professor A.V. Leontovich on that idea. He favored

such a proposal pointing out that it was possible to make the first experiments with the animals trained by the famous circus artist and well-known zoological psychologist, Vladimir Leonidovich Durov. My mentor added that such experiments might be quite interesting since V.L. Durov had been successful in his "mental suggestions" to his animals from a distance, that is he was (to my mind) a good source of transferring mental electromagnetic waves.

Events began to unfold rapidly and favorably. A.P. Modestov, the chairman of the Naturalist Association with whom I had discussed the matter, was not only in favor of my working at V.L. Durov's laboratory but even offered to send a deputation to V.L. Durov consisting of the Association's presidium members. Indeed, on 20 August 1922 a four-man delegation headed by V.P. Modestov visited V.L. Durov's "Scientific Nook." I was also a member of the delegation. V.L. Durov and his associates gave us a warm welcome. A.P. Modestov kissed him and introduced each member of the delegation. V.L. Durov agreed to my working in his laboratory as a scientist, revealing a keen interest in my future work which would be based on his experiments in mental suggestion on trained animals. I submitted my application right then and there.

But I also continued to work in professor A.V. Leontovich's physiological study. Studying the morphology of nerve element preparations in 1923, I made a new assumption to the effect that in addition to the Thompson closed circuit in the nervous system (especially in the "Remakov" system), there may exist also an open oscillation circuit, known in radio engineering as an open "symmetric" vibrator, which emits a so-called "stationary wave." It was this type of open vibrator in the form of an antenna, with a spark discharger and self-induction coil connected to the open-circuit wire, that A.S. Popov used in his first experiments. This scheme was eventually improved: the spark discharger was shifted from the antenna to a closed oscillation circuit inductively connected with the antenna. The advantages of such a mixed system with a "stationary wave" include: the possibility of emitting longer waves (than by a single closed circuit), and a considerably higher

emission energy as compared to the expenditure of the primary energy. Eventually, with the introduction of triode tubes (known as Round tubes in the USSR, and Lee de Forest abroad), a spark discharger was no longer required. Other instruments of the transmitting and receiving radio stations were also gradually improved. Further progress is being made now with the introduction of transistors. The possibilities arising from this improvement are vast and unlimited.

Apparently, something similar to the historical succession has occurred in the human nervous system. The individual nerve elements as well as the nerve circuits made up of them are histologically and morphologically diversified and complex, and this cannot be considered accidental. Like all the other parts of a living organism, the nerve elements and nerve circuits have been and are performing adaptive and protective functions, that is they adapt the organism to the influence of the surrounding medium as well as to the influence of the organism on the surrounding medium. They have undergone changes and improvements for many thousands of years. Nature took care to equip all living matter in the world with highly delicate nerve structures that resulted in the greatest improvement of all the vital functions. The electromagnetic transmission of mental information over a distance is one of the vital functions of the nervous system.

This then gives rise to a logically justified idea: the human central nervous system (including the brain) is a repository of the most sophisticated instruments of biological radio communication whose construction is far superior to the latest known instruments of technical radio communication. There may possibly exist such "live" instruments of biological communication that are still unknown in contemporary radio engineering. From this it follows that a thorough and original laboratory study of these "live" instruments may help us raise radio communication to an unprecedentedly high level by placing entirely new and highly improved radio facilities at its disposal.

A number of exact measurements and complicated calculations I made jointly with my instructor during the study of nerve preparations revealed that the pericellular of the nerve cell (of a frog), for example, representing part of the

nervous structure which possesses self-induction and capacity, is capable of conducting an action current not exceeding 10^{-15} amperes. Thinking over this problem, I came to the conclusion that the nerve preparation under study, as a live conductor, also differs from a metal one by its superconductivity. It seemed plausible to consider such a structure as histologically equivalent to the structure of a number of similar parts in the human nervous system. A.V. Leontovich did not object to the assumption of such an analogy. At the same time I became convinced that any attempt to produce a deflection of the galvanometer needle in my "electromagnetic microscope" by passing through the mentioned nerve preparation an electric current even much weaker than its resolving power, would not produce any positive results. And a 10^{-15} ampere current amounts to only one ten thousandth part of the resolving power of this galvanometer! It was clear to me that although in principle my apparatus may still become the "microscope" of nervous electromagnetic oscillations accompanying the thinking process, the nature of the modern instruments and conductors is such that it produces too much resistance in the apparatus absorbing all of the small power that could be compared to the action current of the nerve. Even an Einthoven galvanometer, which I thought was particularly highly sensitive, could record only a current from 10^{-10} amperes up.

I now faced the problem of finding instruments and conductors without electrical resistance, that is characterized by superconductivity. Unfortunately, all my efforts to find something suitable proved unsuccessful. Such was the level of technical development at that time. With A.V. Leontovich's permission, I switched to research work in V.L. Durov's zoopsycological laboratory at the end of 1923.

FOOTNOTES

Number		Page
1	(Characteristically, in the later editions of his book, which was amended and supplemented [45], Professor A.V. Leontovich also failed to mention the possible existence in the nervous system of an oscillation current and self-induction that are inherent in the Thompson oscillation circuit.)	29
2	(Eventually these schemes were published in the following books: Thought Transference by B.B. Kazhinskiy, Moscow, 1923; Animal Training by V.L. Durov, Moscow, 1924, p. 270; The Ruler of the World by A.R. Belyayev, Leningrad, 1929, p. 169.)	33

CHAPTER II

AMONG THE QUADRUPED AND FEATHERED FRIENDS OF V.L. DUROV

Being in close contact with the animal kingdom throughout his conscious life, the famous Soviet zoological psychologist and merited artist of the circus, Vladimir Leonidovich Durov, was very fond of his quadruped and feathered friends.

It is a known fact that in his youth Durov had become conscious, under entirely accidental circumstances, of the animals' capacity to understand human thought without words or any other audible or visible signals. It happened in the village of Borogodskoye near Moscow. A huge ferocious Ulmian dog was kept locked in one of the abandoned summer homes. He wouldn't let anyone near him. But Volodya Durov bet his friends that he would go into the building and the dog would not touch him. This is how V.L. Durov describes the incident in his book [33]. "I unlocked the door and found myself alone in the house. My friends outside watched through the windows and waited. Hearing the click of the door, the dog rushed at me with a loud growl. But seeing a stranger standing there motionless, he slowed down baring his teeth and still growling. I made a slight move toward the dog, staring in his eyes all the time. The dog was still approaching me slowly, growing louder, the froth dripping from his open jaws, his eyes bloodshot. I continued to move just as slowly toward him. The dog slowed down and so did I. We stared at each other as if trying to read each other's mind; and only the dog's growl and rasping noise broke the silence. Suddenly the dog came to a stop as if frozen in his tracks, and raised his tail, still looking at me fiercely with his small unblinking colorless eyes. We both remained in this waiting position motionless. We both repeated that slow approach and again froze in our tracks.

Those were agonizing seconds that seemed like an eternity. Then the dog suddenly shuddered. His pupils narrowed, the eyes appearing to blend with the color of his muzzle into a nondescript smoky gray; then the eyes appeared to have separated from the gray background and floated upward. I made another small forward step, the dog's eyes seemed to be floating away from me in the air but soon

returned staring at me, the dog still baring his teeth. We were now two feet apart, and as I inched forward it seemed that the eyes were receding again. I made a few more movements and the dog stepped back. I was now approaching faster while the dog kept backing away as if gripped by fear; I followed the retreating dog into the next room, and suddenly he turned tail and ran from me. As we reached the last room, he put his tail between his legs and crawled under a broken sofa. The loud applause outside the windows brought me to my senses. I was let out of the house and triumphantly joined my friends. They stood there amazed -- and enthusiastic. I had won the bet."

Recalling that incident in a conversation with me in 1923 (as we were both preparing the manuscript of his book for the printer), V.L. Durov emphasized that when he first met the ferocious dog he was possessed by an irresistible desire and mental impulse to compel the dog first to stop and then to retreat. But V.L. Durov also told me what he did not mention in his book: He parted with the dog, walking backwards toward the door, and when his friends opened it he lost consciousness and collapsed. His volitional strain was so great that it sapped all his energy.

Later on, working in a circus, the young V.L. Durov frequently observed in other animals (the lion, bear, etc.) a similar capacity to understand human thought from a distance, and obey mental orders. He made wide use of this powerful weapon in the training of animals and the taming of wild beasts.

In a number of experiments the animals were deliberately separated from the experimenter and placed in a different part of the laboratory at a considerable distance from V.L. Durov (who, in this case, was the inductor of biological radio communication). In other words, V.L. Durov succeeded in having the animals intercept his mental transmission from a considerable distance away. He also established the pattern of such thought transference. V.L. Durov's efforts in this field resulted in the development of a Soviet zoological psychology which is far ahead of that science abroad.

One thousand two hundred and seventy-eight experiments in mental suggestions (to dogs) were carried out in V.L. Durov's zoo-psychological laboratory in twenty months (to 1 December 1921); six hundred and ninety-six of them were successful and five hundred and eighty-two were not. This voluminous documentary material was statistically processed by a staff member of the laboratory, professor of zoology of the Moscow State University G.A. Kozhevnikov, who personally submitted it for comment to L.K. Lakhtin, professor of mathemathics at the Moscow State University. This is what professor Lakhtin wrote in his conclusion after studying the material[1]: "There is as little probability to the assumption that the dogs' responses were accidental as there is to the assumption that we can succeed in pulling out a white ball from a bowl containing ten million black balls and sixteen white ones. The dogs' responses were not accidental but produced under the influence of the experimenters." The experiments on Durov's dogs revealed one important pattern. A successful mental suggestion to an animal does not necessarily have to be made by the trainer. It can be made by another person, an experienced inductor. But such a person must know and apply the transference method established by the trainer of the particular animal.

Once in a conversation with V.L. Durov (on 17 November 1922) I asked him to give me some details as to how the transmission of a mental "order" to an animal effects its motor activity. I made the following record of what he told me[2]: "Let us assume that I am alone with the dog Mars, eye to eye as it were. There are no outside interferences, and we are completely isolated from the outside world. I look into Mars' eyes or, rather, very deep into his eyes and beyond them. I make passes at the dog, stroking him slightly on the sides of his head, above the mouth, the shoulders, barely touching his fur. This compels Mars to keep his eyes half shut. The dog points his nose almost vertically, as if it were falling into a trance. My movements deprive the dog of all his will, and he remains in such a state as if he were part of my internal 'ego'. A communication or 'psychic contact' has thus been established between my thoughts and Mars'

subconsciousness. In my imagination I try to keep the object of my thought, sensation or order clearly in mind: it may be an object or an action (I do not think of the words that my designate them) Looking through the eyes and into the brain of the dog, I do not think of the word 'go', for example, but of a motion that the dog is to perform in order to carry out my mental command. At the same time I draw a clear mental picture of the direction and the road the dog is to follow by fixing certain 'landmarks' in my mind along this path (these may be cracks, spots on the floor, a cigarette butt or other small object, etc.); and finally I visualize the place where the intended object lies, particularly the characteristics of the object itself and its distinctive features (shape, color, arrangement among other objects, etc.).

Only now do I issue the mental 'order', as a stimulant to the subject's brain: 'Go', and I step aside to make it possible for the dog to carry it out. By now my thought, image, picture, motion, etc. have already been fixed in the dog's semiconscious mind, and the 'order' compels him to perform the received assignment unconditionally (without any internal resistance) as if he were acting on a natural impulse coming from his own central nervous system. When the mission is completed, the dog shakes himself, apparently satisfied that his intention was carried out."

On the same day, at a conference of the LABORATORY'S scientific council, V.L. Durov carried out one of the most remarkable experiments in the transference of mental 'orders' to a dog named Mars.

In addition to V.L. Durov, the conference was attended by professor A.V. Lecntovich, G.A. Kozhevnikov, G.I. Chelopanov and the zoologist I.A. Lev. My duty was to record the course of the experiments. I tried to see and record every possible detail of the experiment. As it happened, the mentioned experiment was highly important in that it proved not only that Mars was able to intercept all the mental information sent by V.L. Durov, but also another and equally important circumstance. The point is that the animal, having intercepted the idea, sensation and emotion from the outside, experiences them as its own and acts as if

it is obeying the command of its own normal impulse sent by its brain through the nervous system to a particular motor apparatus of its own organism.

Many people were doubtful of this particular important detail in the phenomena of biological radio communication. Professor G.A. Kozhevnikov who is generally sceptical about thought transference over a distance, insisted during the mentioned experiment in the laboratory that if a trained dog does respond to mental suggestions its performance may be compared to that of an actor performing his role in a play. All the movements of the dog in this connection are allegedly involuntary and devoid of any personal emotions and experiences.

To V.L. Durov this assertion sounded like a monstrous distortion of reality. Despite the late hour (it was past midnight), he offered to make another experiment right then and there, and plunged into a discussion of all its details.

The Dog Mars Puts the Skeptics to Shame

Everyone agreed to use the dog known as Mars for the experiment. The experiment was to be held under conditions unfamiliar to the animal. Durov himself offered to accompany G.A. Kozhevnikov through the various laboratory halls to find an unusual object for the dog to pick up. They walked out of the main laboratory hall (where Mars and I remained) into the large vestibule. I watched them through the half-opened door. They stood there about a minute looking over all the objects around them: near one of the vestibule walls was a small cabinet with a rag on top of it, next to it was a refrigerator, a little table under a mirror on the wall with a number of headgears on it; at the other wall was a tall round telephone table. On that table was a telephone instrument and three telephone books of various years and sizes, one of them thicker than the others. Neither Durov Kozhevnikov came close to any of these tables or objects or touched them. Selecting the object for the next experiment (it was a telephone book as I later found out), they both returned to the hall.

Following is a detailed description of the experiment recorded in a special document dated 17 November 1922 and signed by V.L. Durov and myself: As suggested

by V.L. Durov, professor G.A. Kozhevnikov submitted to V.L. Durov the following course of action to be "suggested" to the dog Mars: the dog was to walk out of the room into the front hall, go to the telephone table and pick up the telephone book in his teeth and bring it back. Professor Kozhevnikov at first suggested that the door to the front hall be closed and Mars be made to open it, but that suggestion was rejected and abandoned. The experiment began with V.L. Durov's usual suggestion to Mars. The door to the front hallway was open. After about half a minute under V.L. Durov's fixed gaze, Mars ran to the middle of the room (that the mission was not completed--B.K.). V.L. Durov then put Mars back in the armchair, and held his muzzle up in his hands, fixed his gaze on him and released him. Mars walked to the door leading to the front hallway trying to close it (that is another failure to complete the mission--B.K.). V.L. Durov put Mars in the armchair for the third time, releasing him half a minute later. Mars rushed into the front hallway, reared up on his hind legs near the cabinet and, not finding anything on it, walked over to the table under the mirror; although there WERE numerous objects on that table, he left it without taking anything, proceeded to the telephone table, stood up on his hind legs, picked up the telephone book with his teeth and brought it back. As I have already mentioned, there were thumb-indexed books and a telephone instrument in addition to the telephone book, on that table.

Despite the first two unsuccessful attempts, the experiment MUST BE considered as highly successful. Throughout the experiment everyone remained in the main room. The dog was alone in the front hallway. He was watched by Professor Kozhevnikov through a crack in the open door. V.L. Durov was in the main room, out of the dog's sight."

Later, in his book Animal Training, Durov was to write about this incident: "I will try to look into this performance. Let us assume that the combinative reflex produced by the repeated placing of the dog in the armchair, and the fixation, compels the dog to jump off the chair and want to do something. Let us assume also that I indicated the desired direction to the dog by some involuntary movement. Foresight may have prompted the dog (seeing the half-open door and

being called back when he wanted to close it) to walk through the door into the next room, but as for Mars' further behavior, I cannot make any assumptions. Here is where the mystery begins. There was no one in the next room. The dog was unable to see us. Watching through a crack in the half-open door, Prof. Kozhevnikov saw Mars pass by the table under the mirror, which had a number of objects on it, walk past the refrigerator and another table with some objects on it, and finally approach the telephone table and pick up the one of the three books that had been intended for him. The question I ask myself is whether foresight could have played any part in this. Could Mars have guessed his particular assignment by some previous analogical actions? That was the first experiment with Mars when it was "suggested" to the dog to enter another room and perform a certain task there. The dog may have seen the books on the telephone table every day, but never had occasion to pick them up with his mouth. I have no answer to all these questions. Nor can I assume any coincidence as the tasks were not the same, unless it be an established reflex rapport, that is to pick something up and bring it back. But even this usual and well memorized action was changed in some experiments with "mental assignments."

Such an answer serves to confirm one more remarkable detail of that experiment which, in my opinion, is of utmost importance. Looking for the intended object, Mars not only passed from one table to another. The animal's passages followed exactly the same order in which V.L. Durov had originally looked at those tables. He first looked at the cabinet, then at the refrigerator, then at the table under the mirror, and only after that did he look at the telephone table. Consequently, the appearance and sequence of these four objects in the vestibule had been fixed in the visual memory of the experimenter. The same sequence was noted in the dog's performance. That means that the mental suggestion to the animal transmitted by the man included the latter's visual sensations, the four objects in the room that had been fixed in his memory, in the original order.

We also have a right to consider the phenomenon of visual memory as an animation of the traces in the cerebral end of the visual analyzer (Academician I.P. Pavlov's terms) because V.L. Durov's experiments revealed numerous instances of the formation of similar traces in the brain of the trainer. These traces came to light in V.L. Durov's mind in the process of his mental suggestions to the animals.

Thus the experiment of 17 November 1922 served to establish an indisputable fact of the greatest scientific importance: the mental picture produced in the brain of the dog (the percipient) was exactly the same as that originating in the brain of the experimenter (in this case the inductor). In other words, mental information was transmitted from the human brain to that of an animal, and such a transmission could be made only through the medium of electromagnetic waves emitted by the human central nervous system in the process of thinking and perceived by the central nervous system of the animal.

I Play the Part of a Test Subject

My observations of all the details of the experiment with Mars, and the heated debates that followed, were food for serious thoughts. V.L. Durov's opinion that the emotional reflex induced in the animal produces in the animal his own association of ideas and movements was, I thought, a particularly satisfactory explanation of the "mechanics" of the series of movements made by the dog which finally led it to the performance of the experimenter's mental assignment. I considered it important to test such "mechanics" on myself. On the day after the experiment with Mars (18 November 1922) I came to the zoo-psychological laboratory and asked V.L. Durov to induce some motor reflex in me personally. We both sat down at the large table in the laboratory hall, and we were alone. The following dialogue took place:

Vladimir Leonidovich, you know quite well how to transmit mental suggestions. Compel me mentally to make some movement. I am curious to know what I will think or feel in the process. Can you do it?

Easily, you just sit quietly! Durov said firmly, and we got down to business.

I remained motionless for not more than two minutes and saw my famous interlocutor, without looking at me, take a sheet of paper and scribble something in a hurry with a pencil which he had taken out of the pocket of his favorite black velvet tunic. He then put the note on the table face down, covering it with his hand, and replaced his pencil. Then Durov began to stare at me. I didn't feel anything in particular, but suddenly and automatically I touched the skin behind my ear with the fingers of my right hand. Before I had a chance to put my hand down, V.L. Durov handed me the note from which I read in amazement: "Scratch behind your right ear." Dumfounded, I asked him:

Bud how did you do it?!

I imagined a strong itch behind my right ear and that I had to raise my hand to scratch that spot. I tried to imagine that itching sensation behind the ear as clearly as possible. And that is all. And what did you feel?

Of course I did not feel any transmission. I simply felt like scratching behind my ear.

Durov was triumphant:

That is just the point, you carried out the movement I had preconceived as your own association of ideas and movements, as an order from your own brain, and an order of a dual nature as it were--you felt an itch behind your ear and raised your hand to it, that is to the right ear, as I had intended.

In other words, Vladimir Leonidovich, you sent a short radio transmission from your brain and I, without realizing it intercepted that transmission, I pointed out. You and I are both live radio stations, V.L. Durov remarked jokingly.

That was the end of the short experiment which was highly significant for my theory of biological radio communication.

The Faraday Cage

I have already mentioned that I built and tested (in 1922) a screening device designed to insulate, from an electromagnetic point of view, the experimenter from the test animal in order to prove the electromagnetic nature of the transference of mental information in V.L. Durov's experiments. In that construction I made use of the well-known principle of Faraday's screening cage.

In laboratory work it is frequently necessary to protect the particular area from an external electric field. The English physicist M. Faraday was the first to prove by his experiments that this could be done by inclosing the area in a metal shell that conducts electricity. Although the external electric field produces a charge in the outer surface of such a shell, the space within it remains entirely free of electric field lines. The shell does not have to be solid all around. It could be made of fine wire netting. Faraday would place animals in the cage, induce an electric current in the wire, but the animals remained unhurt. Such a screening cage came to be known as the Faraday cage, or simply a screening device.

At first I built a cage (about a man's size) in which the floor, ceiling, walls and even doors were made of fine metal netting and in some places roofing metal. The very first trial tests revealed that my assumptions had been correct: when the cage door was closed, V.L. Durov sitting inside was unable to transmit to the test animal (the dog Mars) outside a single mental assignment. But as soon as the door was opened, Mars carried out every order with precision. A photograph of this experiment, made on 22 January 1923 (Fig. 11) shows V.L. Durov sitting in the cage and Mars, responding to his mental command, bringing him a notebook. Standing next to the cage near the switchboard is the author. The commutator overlaps the contacts of the ground wire which is connected to the central heating system of the laboratory. This ground wire was reduced in view of the uncertainty about the possible length of the electromagnetic waves involved in the thought transference process or the right size of the perforations in the walls of such an "insulator."

It was assumed that grounding the circuit of the cage would give it a ground potential and amplify its screening effect. But that assumption was later refuted by checking the screening characteristics of our chamber with radio instruments. All we had to do to ensure the blocking capacity of the chamber was to keep its door closed. With its door open, the chamber could not block the passage of the electromagnetic waves[3].

Fig. 11. Second stage of the experiment: Suggestion being made to the animal with the screen door to the cage open. Obeying the mental command, the dog brings the pre-selected note book to V.L. Durov.

Since the screening device produced a marked effect in these experiments and it was assumed that a chamber with solid metal walls would be still more effective than a screen cage, another chamber with solid metal walls made of roofing sheet metal was built at the end of 1923.

The experiments with a new chamber heightened our confidence in the fact that we were on the right road. But we still had to check the screening effect of the chamber with radio INSTRUMENTS. By that time the first new item appeared in the foreign press [24] to the effect that a copper screening chamber had been built (in the U.S.) and tested by using a radio receiver inside the chamber and a transmitter outside. That test revealed that when the chamber door was firmly closed, the man with the radio receiver inside the chamber could not receive any signals from the radio transmitter operating outside. That served to prove our experimental assumption that our chamber blocked the passage of electromagnetic waves.

It then became necessary to build a copper chamber also for the experiments with V.L. Durov's animals. The third chamber, made of copper-iron, was built at the end of 1925 (Fig. 12). It was a 1,130 mm-high parallelipid with a 950 x 910 mm foundation. The chamber had double metal walls, floor and ceiling: the inside walls were made of roofing tin 1 mm thick, and the outside ones of brass sheets of the same thickness. In one of the walls was a door on iron hinges opening outward. The door was also double: it was covered inside with roofing tin, and outside with copper sheets. In another wall there was an oval opening with a metal cover that could be operated from the outside in such a way that the experimenter sitting inside would not know whether it was open or closed.

Fig. 12. An all-metal screening chamber (the third in V.L. Durov's laboratory) with double metal walls: copper (brass) outside, and iron inside.

The screening characteristics of the chamber were checked and officially documented (on 30 December 1926) by the members of the State Experimental Electrical Engineering Institute in Moscow A.V. Astaf'yev, A.G. Arenberg and myself (in the presence of V.L. Durov, professor G.A. Kozhevnikov, professor A.V. Leontovich, and professor A.L. Chizhevskiy).

Sitting inside the chamber with a shortwave receiver, the experimenter was able to intercept the loud signals from a generator of similar waves outside (Fig. 13) only when the chamber door was open. When the door was closed the signals were no longer audible. The tests were made with 2.7, 3.0 and 4.0 meter waves. The chamber had no ground connection. These tests showed that it was not necessary to ground the chamber, and they also convincingly proved that the nature of the phenomena accompanying the transference of mental information over a distance is the same (electromagnetic) as in ordinary radio communication. This prompted me to refer to the transmission of mental information as biological radio communication.

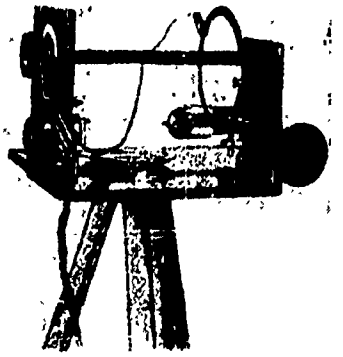

Fig. 13. The UKV radio transmitter, designed for 2 - 4-meter wavelength, which was used outside the chamber when it was tested in V.L. Durov's laboratory on 30 December 1926.

The Two-Number Riddle

Following is a description of another experiment carried out with the participation of Academician V.M. Bekhterev in the zoo-psychological laboratory in 1926. Experimenter V.L. Durov was to "suggest" a mental "order" to the dog Mars to bark a specified number of times.

V.L. Durov and his colleagues were in the laboratory hall. Professor A.V. Leontovich took the dog to another room separated from the hall by two other rooms. A.V. Leontovich closed the doors of these two rooms to make the distance between the dog and the experimenter completely soundproof.

And now V.L. Durov begins the experiment. V.M Bekhterev hands him a sheet of paper folded in half which contains the figure 14 and is known only to Bekhterev. Looking at the sheet of paper, V.L. Durov shrugs his shoulders. He then takes a pencil from his blouse pocket, scribbles something on the reverse side of the sheet and, putting the sheet and pencil back in his pocket, proceeds to the experiment. His arms folded across his chest, he fixes his gaze ahead of him.

Five minutes pass. V.L. Durov then relaxes in a chair. Soon A.V.Leontovich comes in, accompanied by the dog, and makes the following announcement: "As we came to the far room, Mars lay down on the floor. He soon arose, stood up on his hind legs as if listening to something, and began to bark. After seven barks, Mars lay down on the floor again. I thought the experiment was over and wanted to take him out of the room but suddenly Mars rose up on his front legs and again barked exactly seven times."

Hearing this, V.L. Durov hastily pulled the sheet of paper from his pocket and handed it to Leontovich. Everyone saw on one side of the sheet the figure 14, and on the other side, in Durov's handwriting, 7+7. Excitedly the great animal tamer explained: "Vladimir Mikhailovich (Bekhterev) requested me to induce Mars to bark 14 times. But you know that I personally do not recommend suggesting more than 7 barks at a time. So I decided mentally to split the number in two, that is to divide it into two assignments, and transmitted the barking sensation first 7 times and after a short pause 7 times again. And Mars barked exactly in that order."

We were all dumfounded by what we had just witnessed. Even professor G.A. Kozhevnikov, who was present at the experiment, felt compelled to admit "It looked exactly as if a morse code was sent by telegraph: 7 dots, pause, and 7 dots again."

Without exaggeration, I might say that I was in seventh heaven. Durov himself was also pleased with his success, even though the whole thing was just another episode to him. We will cite one of these episodes.

On 9 August 1918, during a circus performance in the town of Dubel'nya (Latvia), Durov was attacked by a trained bear. The infuriated beast dug his teeth into the trainer's arm and twisted it. There was panic in the audience, women and children screamed This is how V.L. Durov himself [33] described his handling of the enraged animal. "The bear reared up on his hind legs and slowly approached me. I kept looking into his eyes and began to retreat leading him after me. It was a game of "out-guessing." I kept inching backward trying to

lead the bear into the stable. I felt, looking into the bear's eyes, that he wanted to leave me alone and walk away. Using all my power of concentration, I continued to look deep into his eyes, mentally ordering him not to take his eyes off me, and kept moving backward. I suddenly felt a familiar suggestion-connected sensation: the bear seemed to float somewhere upward but his eyes kept following me. They seemed to grow larger, then smaller, all the time floating slowing after me. We finally reached the stable. I felt a different surface underfoot and heard the alarming thud of horses' hoofs in the stalls. I shouted 'Alle!' (To your place), and the bear meekly went down on all fours again and, his ears drooping, rushed into his cage. I immediately locked the cage. And then I felt the reaction: I felt dizzy and almost lost consciousness. It was only then that I felt the pain in my arm."

Decisive Experiments of Soviet Scientists

The six experiments with the trained dog named Pikki, described by Academician V.M. Bekhterev [8], are classic examples of the theory of biological radio communication. In four of the experiments, the inductor transmitting the Academician's assignment to the percipient (the animal) was V.L. Durov, and in two of them the Academician himself who had not told anyone about his mental assignment (before the experiment). The experiments were carried out in V.M. Bekhterev's Leningrad apartment, that is under conditions unfamiliar to the test animal. Participating in the experiments also were the physicians working with Bekhterev, Nikonova and Vorob'yeva. These experiments convinced Academician V.M. Bekhterev for the first time that what they had witnessed was a phenomenon of electromagnetic energy of a biological origin.

Without going into the details of the first two experiments, we shall describe the others. Here is what V.M. Bekhterev writes: "This is the gist of the third experiment. The dog is to jump up on the round stool near the piano and strike the right end of the keyboard with its paw. And here is Pikki facing Durov. He stares

fixedly into the dog's eyes holding his head up for a while in his hands. Pikki, now released, remains motionless for a few seconds then dashes to the piano, jumps on the round stool and a stroke on the right side of the keyboard with his paw produces the sound of several discordant notes.

"In the fourth experiment, following a certain suggestion procedure, the dog was to jump up on one of the chairs near the wall, climb onto the round table next to it and scratch a large portrait above it on the wall. It would seem that this was too complicated a performance for the dog. But Pikki exceeded all our expectations. After the usual procedure (looking into the dog's eyes for several seconds), Pikki jumped off the chair, ran to the chair near the wall and just as quickly jumped up on the round table and, standing on his hind legs, reached the lower part of the portrait and began to scratch it with his paws.

"Bearing in mind that the two last experiments were based on an assignment known only to Durov and myself, and that I was standing next to Durov watching him and the dog all the time, it was no longer possible to doubt the dog's ability to perform any type of complicated action.

"To be absolutely certain of that, I decided to carry out a similar experiment myself without sharing my preconceived assignment with anyone. The task was to make the dog jump onto the nearby round table and remain sitting there. Concentrating on the shape of the round table, I looked the dog in the eyes for a while and watched it dash away from me and start running around the dinner table. The experiment was a failure and I realized why: I had concentrated exclusively on a round table failing to realize that my concentration should have begun with the dog's movement to the round table and followed by jumping on to it. I therefore decided to repeat the experiment, without confiding my previous mistake to anyone which I took care to correct this time. Placing the dog on a chair again, I held his head in both hands, ordering him mentally to run to the round table, jump on it and sit down. I then released the dog, and before I had a chance to look around, he was already sitting on the round table. Pikki had guessed my

"order" without the slightest difficulty... I will not make any comments on these experiments. They are in themselves striking enough to deserve attention without any particular comments... The conditions in which the experiments were carried out exclude any possible assumption that the animal takes advantage of some signs unnoticed by the experimenter himself. As for the last two experiments, they not only dispel any doubt on this matter but also provide the ground for the possible mental influence of one individual on the other through the medium of some sort of radiant energy... There is reason to believe that in this case too we are witnessing a manifestation of electromagnetic energy, most probably the Hertzian rays."

We will now describe the experiments on people carried out by the physician-neuropathologist T.V. Gurshteyn. In his report "On the Perception of All Types of Sensations from a Distance," read at the conference of the Society of Psychiatrists and Neuropathologists in Moscow in April 1926, T.V. Gurshteyn reported that in 1925 he had transmitted to a woman-percipient E.G. Nikol'skaya who was at the station Fryazevo of the Dzherzinskaya railroad line (55 kilometers from Moscow) some geometrical figures which she reproduced on paper with uncanny accuracy. It should be pointed out that T.V. Gurshteyn's research methods were approved by Academician V.S. Kulebakin who, commenting on them, noted "The Great Scientific and Practical Importance of Dr. Gurshteyn's Experiments."

Following are some of the recorded characteristic methods and results of T.V. Gurshteyn's experiments borrowed from his unpublished monograph [28]. A screening chamber was used in the 1936 experiments he carried out jointly with two other scientists, A.T. Vodolazskiy (referred to in the record as collaborator No. 1), and L.A. Vodolazskiy (collaborator No. 2). T.V. Gurshteyn was the inductor in the experiments, and E.G. Nikol'skaya the percipient. Engineer M.G. Mark was consultant on radio communication matters. The program of thought transference in these experiments usually consisted of a small number of individual assignments (or, as they are simply called, mental orders), determined primarily by the movements and actions of the hand and foot. We should point out, however, that in the series of experiments carried out on 7 January 1936, for example, a mental

assignment calling for the spoken word, that is an assignment affecting the second human signal system, was successfully carried out. The mental order called for the following statement: "I find it pleasant to sit here." The record shows the following response by the percipient: "I find it pleasant to sit."

The succession of the mental orders had previously been decided on by the inductor and collaborator No. 1. The time (hour and minute) the inductor was to transmit each "order" was carefully recorded. The screening chamber containing the woman recipient and collaborator No. 2 (who recorded her responses) was in one room, and the inductor with collaborator No. 1 in another. The watches held by collaborators No. 1 and No. 2 had been synchronized beforehand. Collaborator No. 2 had only a chronological list of the forthcoming mental transmissions without any indication of their content. He was to open or close the chamber door at the precise moment indicated in the chronology. In transmitting his successive assignments, the inductor was not to know whether the chamber door was open or closed.

Fifteen "commands" were transmitted in three series of experiments, nine of them with the chamber door open and six with it closed. It was found that when the chamber door was open, every command was accurately carried out, but when the door was closed, the woman percipient failed to perform on a single "command," that is, in the opinion of the experimenters, the screening action of the chamber was effective.

In 1940 there were published very important and interesting results of the experimental work carried out by professor S.Ya. Turlygin [64] who had studied the nature of electromagnetic radiation (using a screening chamber) emitted by the human central nervous system under the effect of mental suggestion and hypnotism. His experiments had been supervised by Academician P.P. Lazarev in the laboratory of biophysics of the USSR Academy of Sciences. A more detailed report of these experiments [65] describes the methods of investigation and the equipment used.

A screening chamber was placed in a room which had been made light-, sound- and heatproof. A metal tubule was connected (from the outside) to an opening in the wall of the chamber at the eye-level of a person sitting in a chair. The tubule opening could easily and quietly be covered with a metal (or different) diaphragm. Sitting on a chair in the chamber and facing the tubule was the hypnotist-inductor. That chair was occupied alternately by N.A. Ornal'do and A.I. Belousov. Doctor of Chemical sciences V.I. Aliyeva and engineer V.I. Manov acted as consultants. The human test-percipients were outside the chamber.

As it is well known that the effect of ultrashort waves on a human being causes profuse perspiration, S.Ya. Turlygin decided to use this phenomenon for control purposes in order to establish the time of the beginning and the end of the inductor's influence on the percipient. A cleverly devised capsule was successfully used in this experiment. Before the experiments, the hypnotist-inductor had worked with the percipient with a view to developing in him (by way of mental suggestion) a special conditioned reflex: to fall on his back from position. This induced the percipient to an unconditional and rapid implementation of the mental "command" of the hypnotist, and fall on his back.

The tests revealed that when the tubule orifice was open, the "command" to fall was always carried out when the percipient was on a level with the horizontal tubule. Closing the tubule orifice with a sheet of paper did not affect the procedure. But no such effect could be obtained when a metal diaphragm was introduced across the tubule. This diaphragm produced an insurmountable obstacle for the direct ray between the inductor and the percipient. It also revealed another characteristic. It appeared that the ray could be artificially deflected to a side if a reflecting screen, or a "mirror" in the form of a red copper, aluminum or ebonite plate, were inserted at the tubule outlet at a certain angle to its axis. This is how that ray deflection was discovered.

Assuming that in this case the law of optical reflection was operative, and that the angle of incidence of the ray from the tubule on the mirror is equal to

the deflection angle, A. Ya. Turlygin determined the points where the deflected ray would pass. It was found that the percipient, placed in the path of the deflected ray, was as good a "receiver" as if it were a direct ray. The wavelengths were determined from a number of diagrams produced in the investigations and the use of diffraction lattices, and were found to be within the range of 1.8-2.1 mm^4.

These experiments led S.Ya. Turlygin to an important conclusion: the purely optical picture of the screens deflecting this agent (effect on the percipient--B.K.) from the mirrors, and the diffraction phenomena lend credence to the belief that this agent is an electromagnetic radiation one of whose waves is found within the range of 1.8-2.1 mm. These conclusions were reported by professor S.Ya. Turlygin in 1939 at the conference of the Moscow Society of Natural Scientists. The report caused a great deal of interest and lively discussion whereupon the majority of the reporting scientists (Academician P.P. Lazarev, professor V.K. Arkad'yev, professor P.P. Pavlov, etc.) supported the theory of the electromagnetic nature of the phenomenon under discussion. Recognizing the great scientific value of these experiments, Academician P.P. Lazarev suggested that Turlygin continue his research, making full use of the well-tested equipment including, of course, the screening chamber.

We see that S.Ya. Turlygin investigated the signals responding to one type of induced impulses (as when the percipient falls down, that is the motor impulse). By developing these investigations into the transmission of visual, auditory and sensory impulses, etc., we could determine also their electromagnetic wave parameters, and initiate the artificial reproduction of these "signals" and sensations. Here we should stress the fact that in S.Ya. Turlygin's experiments the inductors "ray of vision" manifested itself physically as a narrow beam of straight-line electromagnetic radiation from the human eyes.

Radio Communication Among Insects

In addition to the experiments carried out in the laboratory itself, the workers of V.L. Durov's Zoo-Psychological laboratory systematically collected materials proving the presence of certain elements of biological radio communication also in various animals, birds and insects. The English scientist L. Harl (London), for example, observing the behavior of certain butterflies, noted that the female moth can invite the male from a distance of several kilometers away. At first it was assumed that the female stimulated special acoustic oscillations in space which are "heard" by the male. But that hypothesis had to be rejected because the observations had been made in the center of a noisy city and the butterfly could hardly have made the sounds to attract the male from the faraway swampy outskirts. L. Harl therefore found it more plausible to explain the observable fact by the insects capacity to emit and intercept electromagnetic waves by their antenna-feelers. Continued experiments heightened the scientist's confidence in that his conclusion was correct. L. Harl claims that he had succeeded in "intercepting" the tones characteristic of the electromagnetic wave emitted by the female through a radio receiver.

The following experiment was carried out by the Soviet entomologist I.A. Fabri who had made a six-year study of this phenomenon on one type of night butterfly. On a summer evening he would put a female butterfly (in a breeding wire cage) on the porch of an isolated summer home in the forest. In less than 30 minutes, male butterflies were flocking to that cage from every direction. Sixty-four of them were caught in three evenings. The males were marked with red paint on their backs, and carried away (in boxes) six to eight kilometers from the house and released. But 40-45 minutes later they were again found near the female. These experiments were repeated a number of times but the result was always the same.

Suspecting that the communication organ of the insects is represented by their feelers, the scientist cut off the natural "antennas" of several males and

discovered that without them they could not receive the call of the female, and no longer returned to her.

Many Soviet as well as foreign scientists are now inclined to accept that explanation as the most probable one. The hypothesis now gaining currency abroad is that the epithelial nerve fibers of the sense organ play the part of a micro-antenna, and that the wave lengths they intercept supposedly range from 8 to 14 microns. That hypothesis coincides with the viewpoint of the Soviet scientists. True, a more detailed examination of the problem would require one more assumption, namely: in addition to the nerve fibers representing the microantenna of the radiating apparatus, the human sensory receptor also has microantennas of the "biological radio receiver" of odorous bio-radiation waves.

Referring to this question, professor Yu. Frolov [73] writes: "It now seems possible not only to discern the physical nature of odors but also to indicate approximately their place in the infrared and ultraviolet part of the scale of electromagnetic oscillations." Emphasizing the physical nature of odors (as distinguished from the chemical nature), the author offers the following experiment as proof. If you place a dish of honey in a hermetically sealed box and install a light filter in the side of the box that passes only infrared rays, the bees would still gather on the filter as if attracted to it by the smell of honey. Actually the smell of honey does not get out of the sealed box. Consequently, the odor characteristics are not of a chemical but physical, that is electromagnetic origin. And if this is the case, then we must admit something else: the bee's nervous system is the "biological radio receiver" of odorous biological radiation waves. The feelers on the insect's head are also the microantenna of this apparatus.

The results of the experiments carried out by Dr. R. Reutler [78] were published in Palestine in 1928. That scientist had been studying the changes in the automatic movements of a live but isolated organ of an insect (grasshopper) occurring under the influence of the nervous system of an approaching man.

Particularly indicative were the changes in the movements of the intestines and ovaries of a female grasshopper.

The following preparation was made up for the experiment. The head and limbs were swiftly cut off with scissors, a cross-cut was made in the Chitin layer on the abdominal side under the thorax, and the abdominal nerve chain separated from the thoracic ganglion. The wall of the abdominal shield was cut lengthwise to the end of the insect's body, bent back on each side and pinned to a cork foundation. The internal abdominal organs were separated from the cephalic ganglions and removed so that the so-called Malpigiyev corpuscles, the ovaries and the entire intestines remained in place intact. The place from where the head had been severed was smeared with collodium. The abdominal nerve chain was then extracted from the preparation with pincers, and the connecting area at its ends cut off with scissors. The final preparation (abdominal cavity) was placed horizontally on the bottom of a glass Petri dish and filled through a pipette with a freshly prepared physiological solution to the top. It was observed through the dish cover that the viscera of the preparation began to move. They continued to be mobile for 10 hours.

When the preparation was completed, the people left the laboratory. Half an hour later, only one experimenter came back and, approaching the preparation within 0.2 meters, looked at it through a magnifying glass. At first he noted the slow rhythmic contractions of the intestines, and still slower movements of the ovaries but somewhat more intensive movements of the Malpigiyev corpuscles. But in the next two-three minutes these movements were considerably accelerated By the end of the fourth minute all the parts were in commotion. The movements continued to accelerate as long as the experimenter stood near the preparation. When he left the laboratory again, all the movements began to slow down to the initial stage which was noted when the experimenter returned eight minutes later. Such observations repeated in 80 different cases, showed that a repeated acceleration of the movements reaches its previous peak 15 minutes after the man has

approached the preparation. The approach of a second man to the preparation tends to accelerate the movements in it still faster.

In another series of 80 tests it was noted that the movements of the viscera in the preparation tend to accelerate when the approaching experimenter contracted and relaxed the muscles of his legs or arms, as well as his jaw muscles, or began to breathe more heavily.

The experimenter thus came to the conclusion that a live human organism produces an effect at a distance on the cells of a live isolated insect organ, and that the cells of the organ are indicators of such an effect. What is still unclear is whether such an effect can be produced by the muscular contractions of an approaching person or by his neuropsychical activity. The experimenter is inclined to believe that the effect depends on both factors including the volitional impulses in the human brain accompanying the contraction of his muscles[5].

FOOTNOTES

Number		Page
1	(V.L. Durov, Animal Training, pp 468-488. At the time of his death (3 August 1934), V.L. Durov had carried out over 10,000 experiments in mental suggestions to animals.)	45
2	(In his book Animal Training V.L. Durov describes the methods used by the experimenter in suggesting arbitrary mental assignments to the animals (an equivalent to the inductor, in my case) effecting their motor activity, and determining the number of barks, sneezes and other acts on the part of the dog (an indicator, according to my theory). See pp. 131, 208, 293, etc.)	45
3	(We should point out, in passing, that the metal screening device used later on in similar experiments by the Italian scientist F. Cazzamali also had a ground wire, and that the consultant on that device was the famous Italian radio engineer Marconi.)	53
4	(The optical phenomenon of diffraction means a disruption of the straight line propagation of a ray as it passes through a narrow crack (lattice) or bends around the edges of an obstacle.)	62
5	(It is obvious [see next chapter for more details], that since the man (experimenter) approaching the preparation in order to observe the movements of the intestines fixed his gaze ("rays of vision") on it, that gaze produced a biological radiation effect, accelerating the rhythmic movements of the intestines [and ovaries].)	68

CHAPTER III

"RAYS OF VISION"

Let us go back to that remarkable individual Vladimir Leonidovich Durov. A clown, an animal trainer and innovator, a zoological psychologist and thinker. His personality looms high in my eyes as an outstanding Soviet scientist, a bold explorer of new areas of human cognition. Actually it was he who in 1880 and later studied all the details of the remarkable capacity of animals (dogs, bears, lions, etc.) in order to understand (or, according to our theory. to intercept and percieve) the mental commands of man without words or any other visible or audible signals.

Using the new terms of biological radio communication, we can now state that this remarkable capacity of the animal is nothing else than a physiological "capacity" to serve as an indicator of biological electromagnetic waves radiated by the human brain in the course of thinking: the animal's brain intercepts and receives the "telepathema" transmitted by the human brain in the course of thinking. And the animals's behavior changes in accordance with the nature of the intercepted "telepathema." This justifies the assertion that at V.L. Durov's discovery is of invaluable scientific importance to biology and the theory of biological radio communication in animate nature.

We are overjoyed by the works of A.E. Tsiolkovskiy who blazed a trail into the cosmos, and I.V. Michurin who was the first to reveal the internal characteristics of the life and "behavior" of plants, and the methods of controlling their life and "behavior." V.L. Durov was a similar pioneer in the field of animal behavior. His method of emotional training is a device for controlling animal behavior by man.

It is noteworthy that in his first random observations, as well as in the many years of experimentation in mental suggestions to animals later on, V.L. Durov ascribed the major importance to the force of the human gaze into the eyes of the animal or "somewhere deeper than the eyes--the animal's brain." After

frequent tests of the force of his own gaze, he became convinced of the "strange" effect of this force on the animal.

Here is one more of the numerous examples described by V.L. Durov [33]. It happened in Moscow on 21 February 1914. Showing his menagerie to a commission consisting of several scientists and newspaper reporters, including the famous newspaper publisher A.A. Suvorin, V.L. Durov walked with him up to a cage containing two beasts brought in from Africa, a lion named Prince and a lioness, Princess. These beasts had been living together peacefully in Durov's cage for three years. Acceding to the persistent request of the Commission members, particularly A.A. Suvorin, that the lion be induced to attack the lioness (which at the moment lay quietly in a far corner of the cage, V.L. Durov looked the lion in the eyes making an appropriate mental suggestion. He concentrated on a mental picture of the lioness sneaking up to an imaginary chunk of meat allegedly lying in front of the lion, and reaching out her paw for the meat.

The lion suddenly roared, jumped on the lioness and bit her. The beasts immediately became locked in a mortal battle, the entire cage shaking with their violent movements. The frightened visitors left the building in a hurry. V.L. Durov left with them.

The lion remained excited for a long time. Some time later V.L. Durov was told that Prince had reached out of his cage clawing the arm of a passing attendant. Durov decided to come back to the cage and try to calm down the lion.

Following is his account of how he did it. "When I returned, I saw the lion pacing the cage restlessly back and forth, and everytime he approached Princess she bared her teeth and growled. I tried to calm the lion down with soothing words but he did not appear to take notice of me and continued his restless pacing of the cage...He finally lay down in the corner of the cage. I walked up to him and caught his eye. Prince bared his teeth and turned away. I moved up closer and caught his eye again. The lion jumped up opening his jaw. As soon as our eyes met, he raised his head, bared his teeth and snorted and I could feel his

hot breath. But his hostile stare was now fixed on me for a longer period. With every slightest move I made Prince would roar, jump to the edge of the cage and scratch the smooth floor. It was now clear to me that the lion did not take my gaze indifferently. Resting from the strain, I shifted my gaze to Princess. This made Prince still more restless. A sharp movement and a hard stare on my part compelled Prince to jump at the cage bars.

Standing in one place, he kept clawing the floor with his front paws as if trying to run toward me. His eyes were now shining with a green phosphorus light, and he no longer took his eyes off of me. He finally lay down, his jaws open and claws sticking out.

As time passed, he began to calm down. Prince no longer swished his tail on the floor, his eyes grew narrower as if he were trying to fall asleep. Suddenly he whimpered softly "Meow-meow," licked his chops and half closed his eyes. I continued to look at him, mentally comforting him, running my fingers through his main, scratching behind his ears--all mentally, of course. His "meow" suddenly sounded as if it had stuck in his throat, and Prince closed his eyes for a few seconds. I walked away from the cage, and the lion quietly and lazily got to his feet and stretched out."

From the point of view of biological radio communication, the above described incident is similar to the one that had occurred in 1880 when the young Volodya Durov had used the force of his gaze to stop the Ulnian dog and compel him to retreat. The biological radiation emanating from V.L. Durov's eyes, along with the "ray of vision" (directed into the eyes and deeper, into the brain, of the animal), having reached the stimulated nerve center of the animal, produced an effect on it which was in itself a stimulant. That stimulant changed the role of the nerve center from an excitement to inhibition.

This entire process could be more clearly understood by bearing in mind the following important psychological pattern established by the outstanding physiologist of our time, Academician A.A. Ukhtomskiy [68]: "Physiological thought

becomes a great deal more complicated with problems and prospects when it is found that the role of the nerve center, as it works along with its neighboring organs, may change from stimulation to inhibition, depending on the particular state of the nerve center at a given moment. Stimulation and inhibition are merely alternate states of the centers determined by the condition of excitement and the frequency and force of the incoming impulses. But the various degrees of stimulating and inhibiting influences produced by the nerve center on the other organs are determined by its role in the organism. Hence the conclusion that the normal role of the nerve center in the organism is not a statically invariable constant, but one of its possible states. In other states, the same center may assume an entirely different significance in the total system of the organism... an actual confirmation of this was contained in the picture described at that time (1911--B.K.) showing that an intensified stimulation in the central swallowing and defecation apparatus caused by the irritation of the "psychomotor zone" of the cortex produces a further intensified swallowing or defecation activity rather than the usual reaction in the extremity muscles. The chief stimulation of the organism at this moment produced a substantial change in the role of certain centers and the impulses emanating from them at the time."

A.A. Ukhtomskiy referred to this dominant role of the major stimulation as "dominance." This state of the dominance is an interaction between a group of nerve centers in the brain effecting the behavior of the animal, that is stabilizing or changing it in a way that is clearly visible to an outside observer. Here is an example. An attempt to take two fighting dogs apart by pulling them away from each other (by the leash collar) will show that each of these dogs will try still harder to get back and resume the fight. That means that a side effect of a new stimulant (pulling the dogs away by the collar to which they ordinarily respond meekly) to an already heightened stimulation of the nerve center (in the brains of both dogs) merely serves to intensify the activity of the major stimulant. But the result of this dog fight would be entirely different if a more

powerful even stunning effect could be produced on them by pouring cold water over them -- they simply would stop fighting. That means that a new and more powerful irritant (cold water) served to change the state of the nerve center (in the fighting dog) from stimulation to inhibition: the major role of the center has now become inhibition.

The same applies to the two above-mentioned cases (with the Ulnian dog and the lion): the biological radiation from V.L. Durov's eyes served as a side irritant, a powerful stimulant changing the role of the nerve center from stimulation to inhibition. No less important is the fact that V.L. Durov thereby discovered a new and theretofore unknown factor which we are only now deciphering: the phenomenon of the bio-radiation effect on the psyche (of an animal) from a distance. In this case the phenomenon is produced through the human gaze fixed on the animal's eyes. This phenomenon, incidentally, provides one more explanation for the effect produced in Dr. Reutler's experiments when an approaching human organism affected the preparation made with live isolated grasshopper organs; the grasshoppers' intestines showed a marked increase in their rhythmic movements. To the extent that the man (experimenter) approaching the preparation kept staring at it (bio-radiation effect), the rhythmic movements of the intestines were speeded up.

A great many observations made in the everyday life of people serve to confirm the seemingly strange fact that when a person accidentally fixes his gaze on the nape of the person in front of him, the latter suddenly turns around and looks back at him. It appears as if the gaze of the first person is something like a signal, a biological irritant, to the other person. One of my correspondents, a Komsomol' V.A.P. from Leningrad who was actively interested in the problem of thought transference, gave the following account of his own sensation when someone stared at the back of his neck: "...sitting in the theater shortly before the concert began I felt as if someone were drilling into the back of my neck, I felt a heaviness and as I turned my head I met the gaze of another man sitting about four rows behind me."

Another interesting fact worthy of attention, in the life of animals, is the frequently observable yellow-green luminescence emitted by the eyes of cats and other predatory animals in the dark. It is a commonly known fact that certain predatory beasts, snakes and fish are able to affect their victim by fixing their gaze on it. That hard stare numbs the victim which loses control over its own movements and becomes the easy prey of the beast. Our working hypothesis (1952) cited below is an attempt to explain these phenomena from the point of view of biological radio communication.

We know that the epithelial cell represents the peripheral nerve end of the human sense of vision, olfaction, taste and sensation. The process of vision in the receptor, for example, is made possible by the visual (neural) epithelial cells of the eye retina which are known as cones and rods. Above them is a very thin layer of pigmented cells containing visual rhodopsin which makes up the retina surface inverted toward the eyeball. There is rhodopsin also in the upper outer part of each rod. The cones contain a light-sensitive substance called iodopsin (sic.). The retina consists of several layers containing nerve cells, neurons. The visual sensation is first intercepted by the neuron ends of the first layer. These ends are shaped like elongated cones. The latter are concentrated primarily in the central part of the retina, particularly in the so-called yellow spot, the area of the clearest vision (macula lutea). The spot is oval shaped, measuring at the most 2.9 mm across. In the center of that oval is a recess (forea centralis) containing only cones. There are about 7 million cones in each eye. A cone has a diameter of 6-7μ; it is about 35μ long.

In the other areas, especially at the retina periphery, still more elongated nerve cells, called rods, are predominant. The diameter of a rod is about 2μ, and it is about 70μ long. There are close to several dozen million rods in one eye. There is a total of about 140 million nerve ends in the retina of both eyes.

The elongated cone corpuscles and rods are so close to each other that the existing spaces between them are almost indiscernible. Unlike the cones which are arranged singly, the rods come in pairs. It may be assumed that beyond the yellow spot on the retina each cone is surrounded on all sides by paired rods, and that the structure of the central part of the retina is morphologically different from its peripheral part where the cones are less intermixed with rods and where the latter are numerically predominant.

No unanimous opinion has as yet been reached in the physiology of vision as to the differences between the functions of the cones and rods; that these functions are different from each other is indicated by both the difference in the morphology of these nerve cells and the marked difference in their size and arrangement on the retina. It is known, for example, that the cone located primarily in the central part of the retina is a light-sensitive apparatus and a good recipient of color sensations, particularly in daylight. The light-color sensation is therefore also referred to as the central sensation. The rod is more sensitive to the monotone grayish-greenish colors of vaguely discernible surrounding objects at dusk and nighttime. The weak light sensation received in this case is also known as the twilight or peripheral sensation.

Extending from below to the cones and rods, as nerve-end apparatuses, are nerve fibers which transmit the luminous irritation further into the granular layer of the longer cells with outgrowths (processes). Characteristic here is that one fiber is found to be connected to several end-apparatuses. The total number of these fibers comprise a special layer of still longer nerve formations. A vertical cross section of the human retina reveals 10 different layers, the last one of which adjoins the vascular membrane of the eye. The light-carrying compartment of the vision analyzer begins with the ninth retina layer which contains the ganglion cells. The axons of these cells form the optic nerve which should be considered as an optic tract rather than a peripheral nerve. The fibers of the optic tract originating in the eyeball extend through a cranium opening to

the large cerebral hemispheres where they are synaptically connected with the optic thalamus neurons in the corpus geniculatum laterale. The external geniculate bodies transmit the visual sensation in the cortex. From there the visual neurons of the third layer lead to the occipital portion of the cortex. The ends of the optic tracts are part of the field of vision of the occipital portions of the cortex. Here the optic sensations are analyzed and synthesized.

The retina functions together with the vascular membrane on which it is located. Inside the eye, the two of them comprise the light-sensitive layer on which the images of luminous objects are reflected. A clear image on the retina is produced by such portions of the eye as the transparent cornea, the iris (which plays the part of an extension-type diaphragm in a photographic camera) and transparent crystalline lens. The ray of light coming from the outside passes through this optic system into the eye cavity which is filled with a transparent jelly-like substance (known as a vitreous body) and gets into a restricted zone of the retina center, which contains mostly cones. The passage of the ray in this optical system is determined by the diffraction indicator of individual media (front and rear surfaces of the cornea, the crystalline lens and vitreous body), the curvature ratio of the diffracted surfaces as well as certain other optic parameters.

When the light ray hits the retina, the rhodopsin decomposes in various ways in areas of this layer producing a colorless formation. It is this chemical change that originates the oscillatory electrical processes in the retina, or rather in the cones and rods. These processes extend further along the optic nerve and reach the cortex

Electricity Everywhere!

Electric processes in the retina were first noted by Holmgren. and their characteristics studied by Einthoven. It is now known that inside the eye of humans and vertebrate animals is the so-called fundus oculi which is electrically negative in relation to the front part of the eye. It was found that the potential

difference is provided only by the retina. When the reticular layer is removed, no potential difference is found in the remaining part of the eye. This circumstance, incidentally, justifies the proposal of the following two principles: 1) if the eye emits biological radiation, such emission would apply equally to the human and animal eye; 2) such radiation emitted by one eye, could be equally received by a human as well as animal eye.

The change in the electric potential difference occurring during a luminous irritation of the eye can be experimentally observed in every compartment of the optic analyzer: in the retina, the optic nerve tract and the optic region of the cortex. The nature of these electric phenomena is well known. The effect of the luminous irritant on the eye is accompanied by definite bio-electric changes in the central compartment of the optic analyzer, the area striata. The increase in the number of electric oscillations produced by the action of a luminous irritant on the eye is observable (with an "electro-retinogram" recording device) throughout the entire eye-irritation period. By contrast, during the continuous irritation of the eye by a light ray the increase in the number of electric oscillations in the area striata is observable only at the very beginning of the irritation ("switch-on effect") and immediately after it ("switch-off effect").

According to the photo-chemical theory of vision developed by Academician P.P. Lazarev, the change in the light sensitivity of the eye occurs in parallel with the degeneration of the optic rhodopsin. Biochemical and electrophysiological investigations show, for example, that the process of adaptation to the dark (the adaptation of the eye itself to the dark) occurs in the retina. It is still not clear, however, whether the adaptation is based on the restoration of the optic rhodopsin or whether such restoration only accompanies the adaption process.

A study of the eye fatigability in a weak light (eye adaptation) made in 1923 in the Institute of Biophysics of the USSR Academy of Sciences under the supervision of Academician P.P. Lazarev, revealed that the optic center of the cortex is practically indefatigable, and that all fatigue symptoms are concentrated

in the periphery of the optic analyzer, that is in the retina. Indefatigability of the optic center, according to P.P. Lazarev, is associated with another function of that center -- periodic reactions of a chemical nature occurring in the optic center. These reactions laid the foundation for the formation of electromagnetic oscillations in the optic analyzer, that is the emission of electromagnetic waves into the surrounding medium. However, it was not known exactly how this was done. Generally speaking, it may be stated that the investigations of electric phenomena in the optic analyzer, including the human eye, have not yet been completed, and that means that the last word about them has not yet been said. There are still unexplored areas facing the researchers who desire to study the origin and rhythm of the oscillation currents in the nerve elements of the retina, particularly in the cones and rods. It may be pointed out though that this applies equally to the forthcoming investigations into the phenomena of oscillation currents in the epithelial nerve cells and other receptor organs: auditory, olfactory, taste and touch.

Back in 1923 we suggested in our book [36] that the sensitive nerve corpuscles of the so-called "Krause bulb" might serve as antenna loops, that is microantennas emitting or receiving bio-electromagnetic oscillations in the organs of touch. Reviewing these problems in greater detail in the previous section dealing with the accoustic organ, we suggested that the capillary nerve cells of the cochlea may be compared to microantenna apparatuses emitting their bio-electromagnetic waves as well as receiving the incoming bio-electromagnetic wave of acoustic frequency from the outside. It is possible that some of the cochlea hair play the part of a receiving microantenna, and others of a transmitting one.

Extending this analogy to the cones and rods of the receptor organ of vision, we can say that they represent microantennas some of which are adapted for receiving incoming electromagnetic waves, and others for emitting biological electromagnetic waves in the process of vision. The receiving microantennas are the cones

inasmuch as they are capable of "receiving" the light rays and are located primarily in the central part of the retina where the light ray usually comes in. The emitting microantennas are apparently the rods inasmuch as they are located mostly on the periphery of the retina where the light ray comes in much less often. Thus one of the functional differences between the cones and the rods is the difference in their "biological radio engineering" purpose. The biological electromagnetic waves emitted by the rods may be called "rays of vision."

The English physicist C. Ross who had studied the optical characteristics of the human eye for many years also believes that the eye emits electromagnetic energy. In 1925 this scientist built an instrument consisting of a single silk thread with a tiny metal spiral suspended from its lower end. A small magnetic arrow was attached to that thread above the spiral. The purpose of that arrow was to fix the position of the spiral in its suspended state. It was found that when a person fixed his gaze into the spiral in such a way that the direction of his stare coincided with the geometric axis of the spiral windings, and then turned his head slowly until the "ray of vision" was positioned at some angle to the spiral axis, the spiral began to turn toward the same angle. In some experiments the angle of such a "force" rotation of the spiral was as large as 60°.

An examination of the structural characteristics of the retina rods, from the point of view of biological radio communication, would justify the assumption that the elongated portion of the rod represents an ultramicroscopic current-conducting tube which is made up of a material covered with a dielectric layer. Every two pair of rods, though closely adjoining, still leave a relatively long canal between these four elongated corpuscles that might be compared to a microwave conductor. This biological wave conductor is the "live" microantenna which directs its electromagnetic waves of the "ray of vision." The initial direction of the "ray of vision" is in a straight line along the geometric axis of the wave conductor. In other words, the ray emerges from the wave conductor in a perpendicular direction to the plane of the retina area containing that wave conductor.

It is quite possible also to accept the second version of the analogy between the rod and a microantenna on the assumption that one rod functions independently of the adjacent rods. Covered with a dielectric layer, such a rod would be a dielectric bar-type wave conductor. The electric and magnetic fields of such a dielectric are not only inside the bar but also outside it. The advantage of this is that the wave attenuation is considerably reduced. That is why in radio engineering the bar-type conductor is usually very thin, with a diameter one-third less than the wave length. In this case, the rod nucleus may be considered as a unique molecular oscillator, a source of energy, and the segment a bar-type wave conductor of the microantenna directing the "ray of vision" perpendicularly to the internal retina surface.

It may be appropriate to assume also that the emission of millimetric and micron electromagnetic waves of the retina is characterized by the well known Cherenkov-Vavilov effect. Let us assume that the elongated portion of the rod is a dielectric wave conductor with a canal inside, and a nucleus is a molecular oscillator emitting electron beams. The interaction between the electrons and the walls of the wave conductor in the resulting concentration of electromagnetic waves produce a relatively powerful and narrow directional emission of micron (or even millimicron) waves, or "rays of vision."

A summation of these assumptions would enable us to portray the following picture of bio-electromagnetic "rays of vision" being emitted by the retina rods. The "rays of vision" leave off from the widely traced plane of the peripheral retina zone which is shaped like a concave bowl b-c (Fig. 14) where most of the rods are located. Concentrating at point g, the focus of this bowl, the rays become somewhat diffused and reach the internal side of the crystalline lens. The latter, followed by the cornea, break these rays in such a way that they emerge from the eyeball as a beam of parallel "rays of vision." This beam of "rays of vision" is therefore directional and can travel a great distance.

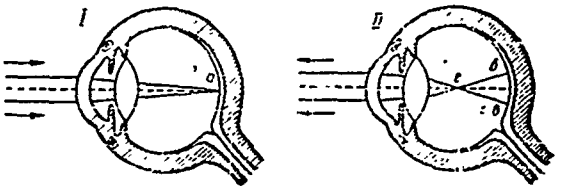

Fig. 14. The organ of vision also has the function of emitting bio-radiation "rays of vision" (working hypothesis):

I - the figure on the left shows the conventional function of the eye -- the retina and crystalline lens diffract the parallel light rays coming into the eye, directing them at an acute angle to point a. This leaves on the retina a clear image of the visual object in a limited zone of its center which is predominated by cones;

II - the figure on the right corresponds to the advanced hypothesis. Extending from the wider peripheral zone b-c of the retina (which is shaped like a concave bowl), perpendicularly to the "bowl" surface, are the "rays of vision" b-g and c-g; this peripheral zone of the retina is predominated by rods. At point g they converge as in a focus. They then separate, falling on the internal side of the crystalline lens.

The latter and the retina diffract them in such a way that they emerge from the eye form of a beam of parallel "rays of vision" beamed into space.

In view of the fact that the retina rods, as "live" microantennas of the "ray of vision," are extremely small, the upper boundary of the "ray of vision" wavelength may be expected to extend far toward the infrared rays of the spectrum. This assumption can be confirmed only through the experiments carried out by S.Ya. Turlygin's methods, but in absolute darkness.

The Yogi Have Known It For A Long Time

But a man is not always conscious of an irritation produced by a "ray of vision" directed at him by another man. The reason may be a very weak energy impulse in the "ray," or the influence of some "side" irritants detracting the man's attention from the irritant which in this case is the fixed gaze of another person. But if a barely perceptible signal-irritant (from a person's stare) is

subjected to a deliberate or involuntary analysis-synthesis in the mind, the man will experience a definite reflex -- and look back.

But how is the "ray of vision" fixed or "felt" in the back of the neck? It seems to us that the explanation for this should be sought in the so-called cone-shaped gland, the epiphysis (glandula pinealis) whose purpose has not been known in the past; it is located above the tubercle of the interbrain (in the recess between the upper monticuli of the lamina quadrigemina, not far from the cortical optic centers). The sides of the epiphysis in a seven-year old child is 12 x 8 x 4 mm. The epiphysis does not grow larger with increasing age or size of the brain. It had been assumed that the epiphysis functioned like an endocrine gland, but this opinion has recently been disputed. The epiphysis still remains a "mysterious" cerebral organ which it has in effect been for centuries. But the abundant blood supply of that organ, its pigment content and lobate structure (resembling that of the retina) indicate that it performs some special functions.

There is a belief that the epiphysis is a rudimentary remnant of a third eye. We should point out that even now there are certain reptiles in New Zealand (spenadon) which have a third "parietal" and functioning eye. By touching the nape with the fingers we can feel at the base of the cranium a bony projection and a recess above it resembling in shape the lateral orbit above each eye. This brings up the question whether there is some "visual" capacity left in the nerve cells of the epiphysis and the short tracts leading from it to the occipital portions of the brain where the optic centers are located.

The answer to this question is provided by the investigations carried out by Marg, Gamss.ki and Gioli (U.S.), reported in 1959 to the 21st International Congress of Physiologists in Buenos Aires (Argentina). These were the first scientists to study the electrophysiological reactions of the epiphysis, as the rear (third) optic nerve tract, to light and electric irritations. Those investigations showed that the light effect on the rudimentary retina of the epiphysis which is found at the outer end of the third optic nerve, or chiasm. (the author's

refer to the third optic nerve as a "supplemental" one), produces a certain reflector response (obviously, of the phosphene type -- B.K.) in that nerve's nucleus. An electric irritation of the epiphysis retina produced the same response as a light effect. But the electric irritation of the nucleus itself produced no reaction in the optic nerve. It was therefore concluded that the functions of the nucleus are only centripetal (but not centrifugal). This is possibly the structural difference between the third optic nerve tract and the other two optic nerve tracts of our eyes which are both centripetal and centrifugal. It was also found that there is a synapse between the chiasma (that is the third optic nerve) and the nucleus.

Comparing the results of these investigations with the frequently observable facts that one person feels compelled to look back under the effect of another person's gaze, we believe that the epiphysis or cone-shaped gland is one of the elements of biological communication in man and vertebrates. Incidentally, this conclusion in regard to the epiphysis function in man is not new: The Hindu Yogi, for example, knew about it many hundreds of years ago.

The following reference is made to this question in the book by the Hindu author Ramacharak, the Bases of the Yogi's Meditation (St. Peterburg, 1907): "...As for the telepathic physical organ through which the brain receives oscillations or thought waves emanating from the minds of other people, it is found near the center of the cranium in the brain, almost directly above the spine, and consists of a reddish-gray, cone-shaped small body or gland attached to the base of the third brain ventricle in front of the cerebellum. The gland consists of nerve matter which contains corpuscles, resembling nerve cells, and containing a large concentration of calcium particles also known as "brain matter." This gland is known in Western science as the pineal of "cone-shaped" gland because it resembles a pine cone. Western scientists have always believed that the functions of this organ had never been thoroughly investigated. Certain anatomists point out, however, that this organ is larger in children than in adults, and more developed in adult

women than in men, which is very significant. The Yogi knew many centuries ago that this "pine-shaped" gland...was an organ of telepathic communication." Thus the reason to believe that the "visual" capacity of the epiphysis, as the third eye, has somehow been preserved. Should such an assumption be justified, it would encourage our hope for the maximum development and utilization of the "visual" capacity of the epiphysis in the future. This might be useful in cases where a totally blind person (whose two visual receptors have been irreparably lost) could have his visual capacity restored, for example, through the use of a theoretically possible electronic optic prosthesis effecting the nerve elements of the epiphysis.

This assumption of ours is not a fantasy. In his work entitled Medical Cybernetics published in 1957, the German scientist A. Vogt [79] claimed that the time was not too far off when science could develop "brain and visual prostheses." Something similar to that was produced in the U.S. in 1958-1959 in one of the Los Angeles (California) polyclinical laboratories. True, that was not achieved through the use of an inductive effect of an electronic prosthesis on the nerve elements of the epiphysis, but by connecting the electrodes of a prosthesis directly to the optical center zone of the brain. As reported by the scientist Button [15], the blind patient began "to see" flashes of light, and said he could see the light of an electric bulb, determine the location of the window in the room by the daylight coming through it, distinguish certain other "luminous images," etc. Here are some of the technical details of those experiments.

Insulated conductors with rustproof electrodes measuring 0.08 mm in diameter were extended to the cortex through openings drilled (under anesthetics) in the rear part of the blind man's cranium. (Since there are no nerve ends of the sensitive tract in the optic centers, the patient felt no pain). A square pulse generator was connected to the two prosthesis electrodes. The primary winding of a transformer in the prosthesis was connected to a low-ampere 67.5 volt battery through a controlled electromagnetic interrupter.

The investigations show that with 25 volts between the electrodes, a current of 620 microamperes and a frequency of 70 hertz, the patient "saw" flashes of light. The experimenters assume that the above-described current fed to the electrodes sets up processes in the cortex similar to those produced by the light flashes of an electric bulb on normal visual receptors. A photoelement was eventually included in the generator scheme. When the photoelement was illuminated, it produced a current in the electrode circuit corresponding to the "vision" of light flashes. The patient with a photoelement in his hand noted the burning of an electric bulb (40 watt) and determined the location of the window in the room by the daylight striking the photoelement. Two pairs of electrodes and one generator with a photoelement were eventually added. With this equipment the patient was able to discern more complicated light images.

The electromagnetic nature of the "ray of vision" could be proved also by instances observable among the beasts of prey. The poisonous snake echis carinatus found in the Asian deserts, for example, usually paralyzes its victim (jerboa or rabbit) by its gaze before pouncing on it. The same hunting method is used by the fish astroscopus which inhabits the Atlantic Ocean. Most of the day it lies on the bottom (on its belly). Its mouth and eyes are on its back. The eye muscles of the fish consist of a system of electric cells. When a small fish comes within its field of vision, the astroscopus fixes its gaze on it. Suddenly the small fish begins to quiver, becomes paralyzed and appears to be drawn into the open mouth of the big fish.

What are the forces that paralyze the victim? It appears that as soon as the image of a small fish comes within the field of vision of the big one, it emits an electric impulse which, upon reaching the victim's nervous system, paralyzes it and makes it easy prey. The radiation from the eyes is purely reflexive, it is a reaction to the visual sensation produced by the image of the small fish on the retina of the large one.

Here is another example. The capybara, a fairly large rodent, inhabits the thick underbrush along the swampy rivers in South America. This animal feeds on grass and plant roots, is fairly mobile on land, and an excellent swimmer in the water and under it. Local hunters have frequently observed the "strange" method used by the huge anaconda snake in its attack on the capybara. Appearing suddenly in front of the capybara, the anaconda raises its head high and gazes into the eyes of its paralyzed victim. Then it pounces on the animal, swiftly coils itself around its body, breaks all its bones and swallows it from the head down.

V.L. Durov actually proved that that animal can be "frozen" by the fixed gaze of man. And if he takes his eyes off of it, it immediately "comes to its senses." The same thing happens when a person fixes his gaze on an animal slightly below or above its eyes. Consequently, in this case, as in S.Ya. Turlygin's experiments, the "ray of vision" represents a narrow beam of directed bio-radiation emissions from the eye.

Thus it may be assumed that an intent look, together with the "rays of vision", carries a maximum radiation energy from the retina rods as well as from the micro-antennas of the unique radiation apparatus contained in the optic lobes of the cortex. What happens is an emission of energy from the cerebral neuron cells of the optic region of the cortex. In this connection, the "impressive" force of a person's gaze reaching the retina of another person (or animal) and continuing to the brain center is the maximum force. When the gaze fixed on another person's (or animal's) eyes is slightly shifted, the force of that gaze can no longer produce an "impression" on his centers. If the first person should close his eyes, no "rays of vision" will obviously be emitted from them and no energy will be forthcoming from the retina rods.

The "impressive" force and duration of the bio-radiation effect of the "ray" of vision" do not necessarily have to be particularly great or lengthy. We know from motion picture photography that a minimum duration (exposure) of not less than 1/20 of a second is required for the human eye to perceive a particular frame

of the film. A faster change of the frames "blurs" the picture, and the eye is unable to see any of them on the screen. It has now been proved, however, that if a distinctive frame were inserted between the usual ones with an inscription of only 2-3 easily understood words, these words would leave a certain trace in our brain center even though we were unable to see them on the screen (because they would be flashed by too fast for us to read them); eventually they would "reemerge" in our conscious (or rather subconscious) either in connection with some recollection of the film or independently of it. Moreover, these words would form our thoughts and desires, that is they would produce an effect on the human consciousness.

A Word About Emotions

How can we explain this phenomenon? Let us look at a white tape, with a straight black line running the length of it, moving slowly (or rapidly) before our eyes. Our eyes will soon become accustomed to the monotony of the cinematographic "dynamic" of that image, and will even become tired of watching the moving tape and the line on it. But should a marked notch (or a cross line) suddenly appear on the tape, our eyes would immediately record it in the subconscious. An examination of similar phenomena recorded by other sensations in the subconscious brain, as for example "fleeting" sound signals of an ultrahigh frequency (Galton's whistle. See the section on the ear) prompts the conclusion that the conditioned reflex, that is the organism's reaction to these sensations, manifests itself also when the intercepted effect of such a "fleeting" signal cannot be analyzed or synthesized in the consciousness.

But the above-cited facts not only serve to confirm the bio-radiation effect of the "ray of vision," they also help us toward a better understanding of this remarkable phenomenon. In the first place, the effect of the "fleeting" word signal shows that in this case we are dealing with the second signal system. Moreover, the experiment carried out by T.V. Gurshteyn in 1958 when the percipient E.G. Nikolskaya obeyed the mental suggestion to pronounce the words "I find it

pleasant to sit here," proves the possibility of including the second signal system in the area of bio-radiation communication. Secondly, we will recall V.L. Durov's experiment with the lion named Prince. At first the lion obeyed the trainer's mental command to attack the lioness; here the force of influence (the side irritant) exerted by the human gaze was the impulse that changed the calm (that is inhibiting) state of the nerve center in the lion's brain to a stimulating state: the lion attacked the lioness. This was followed by another mental "command" from the trainer to the lion: calm down; in this case the side irritant produced in the lion by the human gaze was the impulse that irritated (that is stimulated) the state of the lion's nerve center to inhibition: the lion calmed down. Does this not suggest that the bio-radiation effect on the "ray of vision" in both cases was to some extent "tinged" with emotion: a stimulating emotion in one case, and a soothing in another. Comparing these two cases with the inhibiting effect of the "ray of vision" on beasts (by attacking a victim which had been deprived of its will by this "ray of vision"), we see a striking difference. Possessing a higher degree of reason and consciousness, man is able to "tinge" the "ray of vision" with emotion, to act selectively, and deliberately subordinating the animal's action to his own (human) thinking. In other words, we see that man can organize one type of animal behavior in one case, and another type in another. But the animal cannot act that way. A beast attacking its victim cannot act selectively, but only instinctively (the instinct of maintaining life with food). Here we have a manifestation of the lower stage of consciousness inherent in the animal.

Cited earlier were Academician P.P. Lazarev's conclusions to the effect that the indefatigability of the optic center is associated with another function of that center, namely the periodic reactions of a chemical nature occurring in it. These reactions lay the foundation for the formation of electromagnetic oscillations in the optic analyzer, or outward radiation of electromagnetic waves (that is "rays of vision," according to our theory. B.K.). In other words, the following law is in operation: a chemical process through an electric one, and vice

versa. With these words we should like to emphasize once again the organic connection between the chemical processes in the human brain and the bio-electromagnetic processes.

The conclusions drawn from other investigations are just as important for our theme. It is known, for example, that the introduction into the human organism of an alkaloid of the sap from the Mexican mescalin plant produces hallucinations and facilitates the individual's "perception" of mental information transmitted by another individual from a distance. Studying the effect produced by the mescalin sap in Mexico, the toxicologists noted that among the Mexican Indians (entire groups of whom take that sap during ritual ceremonies) it produces an unusual uniformity of body movements and facilitates and the perception (by all the group members) of the thought transfered by one of them who is considered their chief. The researchers referred to such a rigidly controlled (depressed) state of motor impulses as "empathy," and established that an "empathic" individual reveals a better capacity for perceiving an unarticulated thought than a person in a normal state. Dr. Osmond [80], for example, holds the following opinion on this issue: "As far as I can judge, the state induced by mescalin can be explained by the fact that it disrupts some of the brain functions (in a state of repression), and the brain therefore becomes more sensitive to an outside thought than a normally functioning brain." Osmond believes that inasmuch as the chemism of mescalin changes the sensitivity to the perception of mental information from a distance, this phenomenon (thought transference) should be classified as a material phenomenon.

But the explanation of another very important aspect, not noted by the mentioned researchers, calls for a short digression. We have already mentioned that the paralyzing effect of the bio-radiation wave from the "ray of vision" on the motor center of the wild beast's victim is due to an irritation that changes the dominant role of the nerve center in the victim's brain: the change is from a stimulating to an inhibiting motor movement of its organism.

Consequently, the bio-electromagnetic processes produced in the victim's brain by this "ray of vision" are apparently accompanied by chemical processes (explained by the above cited conclusions from P.P. Lazarev's work). But we must also supplement and change Dr. Osmond's reasoning by a new and weighty consideration: it is obvious that the chemical substances of the mescalin sap acted as the irritant that changed the dominant role of the nerve center from stimulation to inhibition. We can put an equal sign between the "empathy" of an individual and the state of depression of the wild beast's victim. But Dr. Osmond's allegation about "some disruption in the normal functions of the brain" in a state of "empathy" is erroneous. Actually the brain functions remain normal, the only change occurring in the dominant role of the nerve center in the brain from a stimulating to an inhibiting role; this is the correct definition of the state of "empathy." We should add that the only explanation for the material nature of the thought transference to the group of "empathic" people is the effect of the bio-radiation wave radiated by the center nervous center of the chief in the process of thinking.

But this is not all. Professor A.V. Leontovich [45] tells us that in many cases of impulse stimulation and inhibition are accompanied by a so-called assimilation and dissimilation of chemical components in the appropriate organs of the nervous system. This is what it means: the impulse-conducting nerve tissue includes also substances capable of reverse reactions. Such reactions are frequently accompanied by an electric dissociation (degeneration) process resulting in the release of negative ions (dissimilation) or positive ions (assimilation). It may therefore be assumed that an assimilation process, leading not only to a repression of the motor impulses in an "empathic" individual but also to an easier perception of the same emissions, occurs in a state of brain "empathy" under the effect of incoming radiation emissions (the "telepathema" from the chief's brain).

It seems to us that the phenomenal capacity of a person to exert a mental influence on others from a distance is still in an embryonic stage. Those who believe that this brain capacity is moribund, degenerating, etc., are wrong. On

the contrary, it is the beginning of a new and higher stage of development of the human mind, on a new and higher foundation, on the basis of biological radio communication.

This hypothesis is confirmed by the simple law of nature: the more this capacity is exercised, the keener it will become and the greater man's power over nature will be.

CHAPTER IV

THE EAR: AN ANALYZER OF BIO-ELECTROMAGNETIC WAVES OF AUDITORY FREQUENCY

We will try to explain the "mechanism" whereby the human mind can perceive a material sound ("silvery sound") at a long distance from its source.

It is known that the gray matter of the brain, that is the accumulation of ganglion cells, lies near the very surface of the brain and forms its cortex. The center parts of the brain consist of white matter. Several internal concentrations of gray matter, large cerebral ganglions, are found on each side in the lower parts of the brain hemispheres. They consist of an associative (combined) type of neurons. The cortex consists of many rows (5-8) of ganglion cells, each such row usually containing several layers of homogeneous cells. Physiologists believe [35] that the cortex contains an average of 14 billion nerve (ganglion) cells.

The functions of the brain hemispheres include also the activity of the two tract systems, motor and sensitive, and the functions of the central and associative neurons; the latter are greatly predominant over the former. This last circumstance makes the brain hemispheres the major central organ of the human higher nervous system, inasmuch as the associated neurons form the higher centers of human psychic activity. A.V. Leontovich [45] points out: "Like every other movement, the sensitivity of every area of the living body has its own conscious center in the cortex which is usually expressed as follows: every area of our body is more or less accurately "projected" onto the cortex through the "projection fibers" found in the brain. Thus, for example, in addition to the actual leg, the brain has its own so-called "cerebral" leg but the method by which we are conscious of it has not yet been satisfactorily explained (this phenomenon was observed in persons with an amputated leg or arm): several years may have passed after the amputation of the leg, but the amputee continues to complain of a pain (in the large toe of the amputated leg, for example). Similarly projected in the cortex is the movement (or perhaps only the idea of movement) of a particular part of the body. Accordingly, there are two brain centers, psycho-motor and psycho-sensorial, with

tracts leading from them. An irritation of the former is transmitted by the motor tract, and assimilation of the latter is produced by the irritation of the sensorial tracts of the spinal cord. The existence of a projection system of the brain determines the so-called localization (location) of the sensorial centers in the brain. The diagram of these centers is shown in Fig. 15.

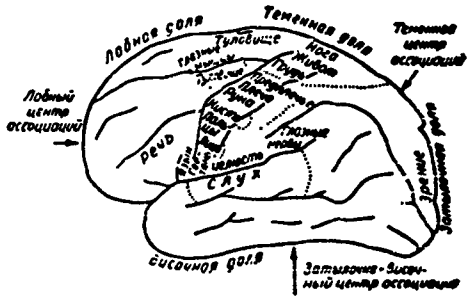

Fig. 15. Location of the sensory centers for the individual organs and limbs in the human brain.

a. Frontal association center b. Frontal lobe c. Parietal lobe d. Parietal assoc. center e. Eye muscles f. Body g. Leg h. Chest i. Should. arm j. Eye nerves k. Speech l. Tongue m. Jaw n. Hearing o. Occipit. lobe p. Vision q. Temporal lobe r. Occipit-temporal associat. center.

According to Academician I.P. Pavlov's definition, "A reflex is an unfailing natural reaction of the organism to an external agent made possible by a certain compartment of the nervous system." A reflex is brought about by an external irritation from the medium surrounding the organism. The initial phase of that irritation consists in the conversion of external energy to a nervous process. This conversion is made by the receptor (a receptor is a nerve cell/nerve element/ which is the end of the nerve fiber receiving the external irritation) which in this case is a capillary cell of the auditory nerve in the inner ear cochlea. From the receptor the process spreads (along the centripetal nerve filum) to the cerebral end of the analyzer. Consequently, an "auditory" reflex is impossible without an analyzer. Under normal sound-reception conditions, the analyzer is the initial, middle and part of the entire auditory nerve tract, or auditory reflex arch.

I.P. Pavlov visualizes the nerve tract or reflex arch as three interconnected apparatuses: 1) the analyzer, 2) connecting or closing apparatus; 3) performing or closing device. He came to the conclusion that "the large hemispheres represent primarily the cephalic end of the analyzer. Consequently, the large hemispheres are also occupied by "receiving centers," that is cerebral ends of the analyzers" (I.P. Pavlov, A Twenty-Years Objective Study of the Higher Nervous Activity. Petersburg, p. 95).

The auditory analyzer consists of a receptor, that is a capillary cell in the inner-ear cochlea, and an auditory nerve in the cerebral cells in the large hemispheres where the auditory nerve terminates. Hearing is a function of the entire auditory analyzer, and the higher analysis of the hearing sensation is made by the respective ganglion cell in the cortex which is the cerebral end of the analyzer. I.P. Pavlov showed that the cerebral end of the analyzer is in itself a very complex mechanism. It consists of a nucleus of the cerebral end of the auditory analyzer, the main receptor of the sound irritation from the nerve element, and a number of other elements of this analyzer scattered in the cortex.

I.P. Pavlov proved that the analyzers are necessary for adapting the human organism to the surrounding medium. The unity of the organism and the external medium and its dependencies on the external world are manifested in the form of a reflex. It thus appears that the inevitable and natural reaction of my brain to the sound irritant coming in the form of a bio-electromagnetic wave (of auditory frequency) from my dying friend in 1919 produced an inevitable and natural reflex on my part: I propped myself up on my elbow and made a number of movements looking for the source of the sound. And conversely, that reflex was the result of an electromagnetic wave of a biological origin received by my nervous system.

Do my views contradict those of the brilliant scientist I.P. Pavlov on the higher nervous activity? I do not think so. First of all we shall cite some of I.P. Pavlov's views on suggestions in general. "A suggestion is a most simplified and typical human conditioned reflex...Some day we may possibly learn how to make

suggestions to animals in a hypnotic state" (I.P. Pavlov, Lectures on the Functions of the Large Hemispheres. Lecture No. 23, Leningrad, 1927).

The Pavlovian theory neither confirms nor rejects the possibility of bio-radiation emissions from the central nervous system; nor does it prove their existence. As is known, I.P. Pavlov himself never dealt with the electrophysiology of the nerves. He was interested primarily in pure physiology. In an article dedicated to the memory of his collaborator A.V. Samoylov, I.P. Pavlov: "I have been and am a pure physiologist, that is a researcher studying the functions of individual organs, the conditions of their activity and the synthesis of their functions in the over-all mechanism of a particular compartment of the entire organism; I am not much interested in the function basis of the organ itself or its tissue as this requires primarily a chemical or physical analysis."

Once during a visit to I.P. Pavlov's laboratory (in 1925), Professor A.V. Leontovich told him about V.L. Durov's experiments in mental suggestions to animals, and the experiment results obtained through the use of B.B. Kazhinskiy's screening chamber. But I.P. Pavlov flatly refused to discuss the effect of the emotional "tinge" on the animal reactions produced by V.L. Durov. It is a known fact, however, that I.P. Pavlov was favorably inclined toward the work of his pupil V.U. Chagovets on the electrophysiology of nerves, and offered him the use of his laboratory for electrophysiological research. There is no doubt that I.P. Pavlov knew that V.U. Chagovets was the founder of the ionic theory of irritation which, in effect, served to prove the electric nature of the psychic processes. He was also familiar with the views and work of P.P. Lazarev who used the ionic theory of irritation for his assertion that the phychic process is accompanied by the emergence of an electromagnetic wave in the surrounding space, and that when the wave reaches the brain center of another individual, who manifests the same reaction at the same time, it puts him in a state of stimulation. In other words, I.P. Pavlov undoubtedly knew that the work of P.P. Lazarev and V.U. Chagovets at that time (1920) had already made it possible to approach the phenomenon of thought

transference over a distance from the point of view of electromagnetic waves generated by the nerve cells of the brain. A great scientist with a wide grasp, I.P. Pavlov apparently found it useful to offer his laboratory for research into the electrophysiology of the nerves even though he personally did not study those problems.

Later the I.P. Pavlov school initiated a study of the effect of an electromagnetic field on the higher nervous activity[1].

Two-Way Communication Circuits in the Nerves

Let us go back to the reflexes produced by auditory perceptions. We believe that the cochlea containing the Corti organ is a receptor apparatus of the auditory analyzer converting the energy of sound waves to nervous stimulation energy, and that the system of these nerve elements, together with the cerebral end of the auditory analyzer, comprises a closed two-way communication chain of the Thompson oscillation circuit.

Accepting these premises, let us see how they can be used to explain my perception of an outside bio-electromagnetic wave in 1919 with a frequency characteristic of the high tones of a "silvery ring."

In his description of several structurally different ganglion cells, A.V. Leontovich points out [47]: "...There are a number of nerve characteristics which tempt tone to treat them as tracts and apparatuses for the conduction of electricity...It is quite obvious that what we are dealing with in this case are not accidental structures but apparatuses designed according to some definite plan with a definite function-structure relationship." Such an arrangement, for example, justifies our consideration of the ganglion pyramidal cell of the brain (see Fig. 16 borrowed from A.V. Leontovich's mentioned work) with its numerous internal fibrills and their ultramicroscopic "plaques" (plates, buttons, pins, etc.) on many of their ends inside the cell, as resembling several different types of radio tubes. Thus it may be assumed that some of these tubes play the part of generators, emitting bio-electromagnetic waves into the atmosphere, while others are detectors,

detecting the incoming bio-electromagnetic wave from the outside. In the first case we have a radio generator connected to the oscillation circuit of some chain of nerve elements in the human organism, in other words a "biological radio transmitter," and in the second (the radio detector) a "biological radio receiver." Let us examine the "internal" functions of both of them when they are separately located in the system of the auditory analyzer.

The auditory oscillations of a frequency characteristic of a "silvery ring," received by the capillary nerve cells in the main cochlea membrane of the auditory receptor, the "biological radio transmitter," were transmitted along the auditory tract to the cortical end of the audicatory analyzer in the brain. In this process the conductors of the neural action current were not only the centripetal fibers of the neuron chain from the receptor to the cerebral end of the analyzer, but also the centrifugal fibers of another neuron chain running from the cerebral end of the analyzer to the receptor. These two neuron chains formed a single electrically closed oscillation circuit in which an oscillatory bioelectric current began to circulate. The circuit consisting of two neuron chains (or two halves) includes solenoids, condensers, a generating "radio tube" and an energy source (Nissl granules in the ganglion cell nucleus). A bioelectromagnetic wave of an appropriate frequency was emitted externally. But the bio-electric irritation (stimulation) of the cerebral end of the analyzer was accompanied by an analysis and synthesis of the intercepted ringing sensation in the brain of the "biological radio transmitter," and the intercepted auditory signal was evaluated by the human consciousness as a "silvery ring." That is how that sound was heard and identified if the given brain was conscious, or was "heard" but not identified if the brain was alive but not conscious. In the latter case the brain could not analyze or synthesize the incoming auditory signal (from the receptor).

But there is still another possibility, and that is when the auditory signal coming from the outside is not analyzed or synthesized when the brain is in a normal state. We know of the following experiment carried out by the famous laboratory

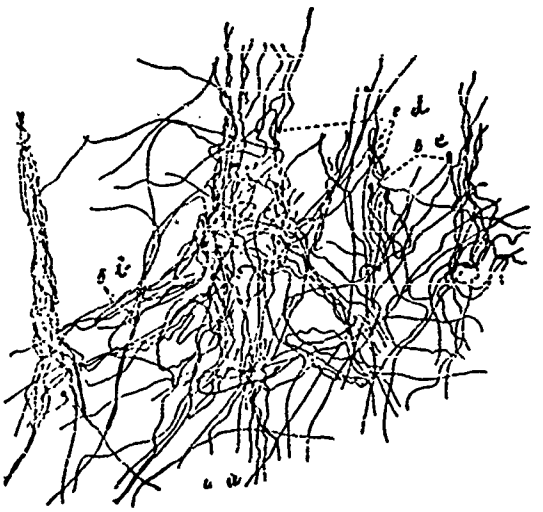

Fig. 16. The numerous thin fibrillar fila a with ultramicroscopic varicose intumescences b, plates (plaques) c, knobs and spines d, etc., many of whose ends comprise the soma (corpuscle) of the ganglion pyramidal cell in the human brain (according to Ramon-y-Cajal)

institute of physiology. A man placed in a soundproof chamber puts his hand on a pair of contacts to which (as he has been instructed before) a weak and safe electric current may be connected. When the current is turned on, the man immediately jerks his hand back. Repeated tests develop a stable hand-jerking reflex. But a sudden change is introduced into the experiment, unknown to the test subject: a minute before the current is turned on, a Galton's whistle in the chamber, unseen by the subject, is activated. Its high frequency sound lasts as long as the current. But the human ear cannot hear that sound, and the subject believes there is complete silence in the chamber. The test involving the simultaneous inaudible sound and electric current are repeated several dozen times with different intervals between them. The observers outside the chamber can see (through a glass window) that in every test the subject jerks his hand back. But then another change is introduced into the experiment (again without the subject's knowledge): this time only the "inaudible" sound is turned on but not the current, and the observers can see that the subject keeps jerking his hand away as if his hand were touching a

current. If you ask him why he does it, he would say he thought he felt the current. Thus a conditioned reflex to an additional irritant (the inaudible Galton's whistle) was developed whereby the organism reacts even though the effect of this additional irritant can no longer be analyzed or synthesized by the brain. The impression of what we shall call "fleeting" signal (sound) as an additional irritant did not reach the consciousness of the test subject although it was reflected in his nervous activity; it produced a response reaction. That means also that the human ear can still preceive the sound of Galton's whistle but the effect of this signal as a sound irritant is reflected only in the human subconsciousness. This "subconscious" action should not be contrasted to the conscious: our consciousness manifests itself in both cases but in different degrees.

We know from the conclusions based on professor V.A. Poderni's experimental work that a sensation received in the brain first appears in its subconscious sphere and is then formed in the conscious sphere. We must therefore assume that there are actual cases when the effect of a particular irritant, reflecting a phenomenon of the external world in our consciousness, can reach only as far as the subconscious fear of the brain and still produce a reaction on the part of the organism.

The bio-electromagnetic thought wave emitted by the "biological radio transmitter" brain with a frequency corresponding to that of the oscillations of the "silvery ring" reached the zone of the "biological radio receiver." The capillary nerve cell of the "biological radio receiver's" auditory receptor, as a micro-antenna or indicator tuned to a wavelength corresponding to the oscillations of the "silvery ring," intercepted that wave and formed an oscillation current with a corresponding frequency in the circuit containing that "indicator." This activated the entire oscillation circuit at that frequency and set off a vibration of the capillary nerve cells in the same cochlea area of the "biological radio receiver's" auditory receptor as in the cochlea of the "biological radio transmitter." The vibration produced the same bio-electric stimulation (irritation) of the cerebral

end of the auditory analyzer (biological radio receiver) as the number of oscillations of the "silvery ring" intercepted by the auditory analyzer of the "biological radio transmitter." This irritation was accompanied by an analysis and synthesis of the auditory sensation in the "biological radio receiver." The sound was thus identified in the brain as a "silvery ring" "heard" by its own ear. True, we still do not know how the brain can evaluate the nature of an intercepted sound as a "silvery ring" for example.

This suggests a somewhat modified version of the auditory organ: it analyzes not only the already known and usual sound irritations but also the hitherto unknown irritant, a bio-electromagnetic wave of auditory frequency, intercepted by the brain from the outside.

The above described working hypothesis of the bio-electromagnetic oscillations in the human nervous system leads to an entirely new understanding of the hitherto unknown physiological purpose of the ends of the centrifugal nerve fibers in our receptor sensory organs. While the centripetal nerve tract conducting the sensation to the brain represents one-half of the closed chain of the oscillation circuit, the centrifugal nerve tract is the other half. Only in these conditions does the circuit actually become "closed," the same oscillation current circulating in both halves; it is this current that Academician V.A. Leontovich had in mind when he referred to the neuron as "an oscillation current apparatus." In our opinion, the centrifugal nerve tract plays the part of a feed-back in the closed oscillation circuit and comprises one-half of that circuit. The other half is the centrifugal nerve tract.

Our hypothesis enables us to understand still another, hitherto unexplainable, physiological phenomenon, and that is when a legless invalid complains of pain in the large toe of his missing leg. It is the presence in the nervous system of an oscillation circuit consisting of two halves (centripetal and centrifugal) that provides the ground for the formulation of this explanation. The "projection fibers" (using A.V. Leontovich's terminology) mentioned earlier represent the cerebral

part of the oscillation circuit whose two halves, the two nerve tracts (centripetal and centrifugal), reach the cortex from the large toe.

If these two tracts were cut in the course of the amputation, a slightly painful irritation of the nerves remaining in the healed scar will stimulate the still undamaged portions of both halves of the oscillation circuit. This stimulation, occurring in the form of an oscillation action current, will reach the "projection fibers" in the cortex of the legless man and will be analyzed, synthesized and identified in the brain as a painful sensation in the "large toe" of the missing leg.

Pain At a Distance

It appears, however, that the sensation of a sharp pain in particular peripheral organ may be felt in the consciousness of one person when it is actually experienced by another person who is far away from him. Such was the very interesting case reported to me in a letter of September 1959 by the literary critic of the Azerbaidzhan Dramatic Theater, G.V. Kornelii (Baku). On 18 July 1918, his aunt E.G. Varlanova who lived in Kokand suddenly felt a sharp pain in the left chest area. The pain persisted for a number of days. A thorough medical examination failed to reveal any visible symptoms of any disease in the left part of the chest.

Being in the habit of jotting down interesting experiences, the "patient" recorded this unusual incident in her diary. Then the pain passed away, and everyone forgot about it. Arriving in Baku early in 1921, Varlanova received a letter from her married daughter M. I. Kurtoshvi'i who was living in Batumi. In her letter the daughter informed her mother that on 18 July, 1918 she had undergone a very serious and painful mastitis operation in the left part of the chest. Recalling and rereading her entry in the diary, Varlanova was convinced that the time she felt the sharp pain in her left chest coincided with her daughter's mastitis operation. Thus a telepathema," the daughter's sensation of pain, was transmitted

to the mother over a distance of 2,700 kilometers (the distance between Kokand and Batumi).

Our theory would justify the assumption that in this case the bio-electromagnetic wave emitted by the brain of the sick daughter in Batumi with a frequency corresponding to the sensation of sharp pain in the left chest, reached Kokand where the mother lived at the time. The ganglion cell of the mother's cortex, functioning as a detector, intercepted that wave and produced an oscillation action current of a similar frequency in the closed nerve circuit of her left chest. The result was a vibration of these cells at the same nerve-end area in the left chest of the mother as it was in the daughter. This vibration in the mother produced the same bio-electric "painful" irritation of the sensitive analyzer in her brain as in the daughter's brain. The brain then analyzed and synthesized the morbid sensation as "her own" sharp pain in the left chest.

But we are astonished by one particular feature, and that is the insignificantly low energy emitted by the brain of the "biological radio transmitter" in the transference of sensations and experiences over a distance. It appears that this small and diminishing energy is adequate for the activation of the reflector instrument of the "biological radio receiver," this remarkably delicate and perfect natural instrument. Whether we will ever achieve such a state of perfection in the attempt to develop such an instrument is a matter of conjecture, but we must work in that direction.

Working jointly with V.L. Durov in 1924, we sketched the following action diagram (for his book) of the mental energy radiated by the brain of the "biological radio transmitter" "the waves of the oscillating mental energy (electromagnetic oscillations of a certain frequency) emitted by the nervous system propagate spheroidally in all directions producing an alternating energy (electromagnetic) field at every point of the surrounding space. Under the effect of the mental energy waves, such point in that space (field) will have a variable potential. Thus if these mental energy waves come across a suitable conductor, that is a receiver

(in this case the nervous system of another living creature), they induce in its organism an oscillating current characteristic of the radiated mental information by imparting variable potentials to its different points. The induced current usually has an insignificant oscillation amplitude, and it cannot therefore be received by every nervous system but only that whose own oscillation corresponds with that of the radiated wave, that is those waves are synchronized. In view of the high speed of the wave propagation, about 300,000 kilometers per second (the speed of light), the oscillations of the radiated mental information appear and disappear in the receiving nervous system simultaneously with their appearance and disappearance in the radiating nervous system regardless of the distance between these two systems. However, when the radiated mental information enters a brain attuned to its frequency, it can be identified in the consciousness only when the receiving subject is in a state of calm (sleep, trance, hypnosis, and the absence of personal thoughts). In that case the mental information penetrates to the center of the brain and, having passed through a microantenna and a number of receivers, follows the law of induction by producing the same arrangement of the brain particles as the one obtained in the transmitting subject at the time this particular thought was transferred. The receiving brain gets the reflex from the intercepted mental information, a stimulus to work, whereupon it continues to intercept one mental thought after the other, if it is in a trance or under hypnosis, or continues to work independently in the assigned direction, if it is not in a trance. The effect of the intercepted thought is manifested in the receiving brain in the form of imagination: optic, sound, sensory, gustatory, olfactory, and finally, complex thoughts. Such an opinion about the thinking processes, from the point of view of weak currents, now makes it possible to draw an analogy between the function of a radio station and the nervous system of a living organism."

It would be appropriate here to quote Academician P.P. Lazarev [41]: "We therefore should consider it possible to intercept a thought from space in the form of an electromagnetic wave, and this is one of the most interesting problems

of biological physics. A priori mention should be made, of course, of the enormous difficulties involved in finding these waves. It will take a number of years of strenuous effort before these phenomena can be demonstrated in practice, but at any rate their existence is suggested by the ionic theory of stimulation. The transmission of thought into space provides a definite basis for the explanation of such phenomena as hypnosis, suggestion and "mediumism," and is undoubtedly quite interesting from a theoretical and practical point of view."

It is a known fact that the Corti organ of hearing (the cochlea or the inner ear), which is a receptor of sound sensations, is capable of intercepting individual sounds of speech but it cannot analyze (much less synthesize), nor can it select those sounds that may lead to an understanding of the speech. This complicated process of sound analysis and synthesis which is in effect a process of consciousness or thinking, takes place in the cortex. The sense of hearing itself, as a basis for speech interception, is formed (from infancy on) and constantly trained under the influence of the sound signals perceived together with speech.

The very close association between the sense of hearing and vocal signals is produced by the contact between the cortical end of the auditory analyzer, located in the rear compartments of the upper left temporal gyrus, and the vocal compartment of the cortical end of the motor analyzer, located in the rear compartments of the left frontal gyrus. It is important to point out that human speech (according to I.P. Pavlov), is accompanied by kinesthetic[2] irritations flowing to the cortex of the speaker himself. They (the irritations) are the signals facilitating the regulation of normal speech processes, and generally play an important part in the complicated process of thinking.

I.P. Pavlov's brilliant definition of speech is very important to an understanding of this role: "If our sensations and ideas about the surrounding world are, to us, the first signals, then speech, particularly the kinesthetic irritation flowing to the cortex from the vocal organs, are the second signals, the signals of signals. They represent a distraction from reality and facilitate a generalization

which is part of our special human higher thinking; this at first evolves into a general empiricism[3] and finally into a science, a weapon of man's advanced orientation in the surrounding world and himself" (I.P. Pavlov, Complete Works, Vol. III, 1949, p. 490).

This is how the great teacher of mankind, V.I. Lenin, defined the concepts of sensation and cognition: "Sensation is the resulting effect of matter on our sensory organs" (V.I. Lenin, Materialism and Empirio-criticism, Moscow, 1953, p.41).

FOOTNOTES

Number		Page
1	(See F. Petrov, The Effect of a Low-Frequency Electromagnetic Field on the Higher Nervous Activity, "Transactions of the I.P. Pavlov Institute of Physiology, Vol. I, 1959, p. 369.)	96
2	(Kinesthesia [from the Greek words kineos--movement, aisthesis--perception] is a motor sensation. Kinesthetic irritations are sensations of motor irritations.)	104
3	(Empiricism [from the Greek word empiria--experience] is a school of philosophy which considers human sensory experience as the source of cognition.)	105

CHAPTER V

HOW MATTER (BRAIN) THINKS

I already had occasion in my previous book [36] to compare the various types of dead energy losses in an oscillation circuit of a radio station with the same type of losses in an oscillation circuit of the nervous system in a live organism. In particular, I pointed out that the capacitor hysteresis losses in the neuron contacts (synapses), according to P.P. Lazarev's mentioned ionic theory [43], determine the physiological phenomenon of memory (and I therefore wrote that "this loss cannot be considered a dead loss").

Hysteresis (from the Greek word hystereo -- I lag behind), a phenomenon observable in plate condensers of a radio station, means that if a condenser is separated from the source of electric power when its armatures are fully charged, it will begin to discharge but only to a certain point beyond which a smaller charge will still remain (residual capacity). A complete discharge would require the application of an electric current, but in a reverse direction, that is with a changed charge sign in the armatures. A condenser hysteresis (or residual capacity) is explained by the fact that the condenser armature molecules, having been regrouped under the effect of the electric tension (during the charge), retain the nature of the new regrouping for an indefinitely long time.

Of similar significance to the memory phenomenon in the human psyche is the magnetic hysteresis of the neuron solenoid windings, as live neuron "self-induction coils" in the cortex. The closed oscillating circuit within the two neuron tracts (centrifugal and centripetal) of the auditory analyzer which, according to the law of resonance, was first to intercept the bio-electromagnetic wave coming from outside, passes the wave-created nerve impulse through all the circuit elements including the cortical (cere ral) end of the auditory analyzer included in that circuit. Part of the energy expended in the process (Nissl granules) is used for regrouping the "flagellum" atoms of the nucleic acid of the nerve cell nucleus (in this terminal area of the analyzer), and puts the molecules of this "flagellum" in

a state of hysteresis, that is in a residual state of the molecules following the passage of the oscillation process. The result is a change or transformation of one state of the "flagellum" molecules to another, something like a trace of the previous oscillation process. And when a new series of similar oscillations of a similar sound signal ("a silvery ring," for example), this time intercepted through the auditory receptor, passes through the same cerebral end of the analyzer (in my brain) again, the neural (energy) impulse of this oscillation series does not change (the already changed) state of the atom group in the "flagellum" molecules.

The second impulse, following in the wake of the first neural impulse, merely refreshes and revives these traces, repeating the already "familiar" vibrations of the given cell; and this, upon an analysis-synthesis of the sound signal, is perceived by the man as a "recollection" of the first . This, in effect, is a memory of something heard in the past.

Actually it was only I.P. Pavlov's theory of the higher nervous activity that provided the first truly materialistic explanation of the memory phenomenon as a physiological process in the cortex. Stimulation foci are produced in the cortex under the effect of a particular external irritant. Since the nervous system can be influenced simultaneously by numerous irritants, many irritation foci can be produced in the cortex. They are not isolated from one another. On the contrary, numerous connections (associations) are constantly developed between them. Academician I.P. Pavlov called these connections temporary because they appear and disappear and emerge again between different foci of irritation. It is for this reason that the human brain cannot only impress a particular phenomenon upon his memory but can also recall it at will or involuntarily much later. As they disappear, the stimulation foci leave certain traces, or "imprints," in the brain. The very word "impression" is indicative of the process of "imprinting" an experienced psychic sensation in the brain.

Memory, a Kind of Hysteresis

We are further justified in interpreting the phenomenon of memory as a revival of the traces (that is as a physical phenomenon of hysteresis) in the cerebral end of the analyzers because V L. Durov's experiments revealed numerous proofs of the formation of similar traces in the mind of the animal trainer. These traces continued to manifest themselves in the course of V.L. Durov's mental suggestions to the animals. V.L. Durov himself frequently noted these phenomena in his experiments and referred to them as "a revival of traces remaining in his brain from a previously changed mental assignment." We shall repeat the appropriate portion of the quotation from the document signed by V.L. Durov describing the details of his experiments of 17 November 1922. Describing how the dog came up to the door leading into the front hall, stood up on his hind legs as if intending to close it (instead of going through the door into the front hall), V.L. Durov concludes: "It is clear in this case that the traces remaining in my mind from the cancelled proposal by Professor Kozhevnikov to close the door to the front hall produced a certain effect." Actually, this revival of the memory traces (as a physical phenomenon of hysteresis in the cerebral end of V.L. Durov's analyzer) is in itself an important proof of the biological radio communication that took place in this part of the experiment: had it not been for that radio communication, the dog would not have stood up on his hind legs near the door (as if intending to close it).

Such is the nature of the verbal thought transference. This is what V.L. Durov says about it: "Before discussing the suggestion mechanism, we shall try to determine the process of ordinary thought transmission from one person to another through verbal symbols (speech signals). The verbal transmission of thoughts is a process leading to the revival of traces in the cortical centers of the percipient; the trace left in the brain by external impressions is capable of being revived both in the experimenter and the percipient. The revival of the desired trace in the percipient's brain is an action leading to the required trace which may lead

to the expected reaction (produce the required reflex--B.K.) through the adhesion of one trace to the other. The perception of a certain idea is a process of establishing associations and conditioned reflexes. In the case of people, this perception occurs through the use of the verbal symbol (the second signal system, according to Pavlov.--B.K.), but, in my opinion, the verbal symbols in animals are replaced by another language, that is an understanding of the movements of all the living creatures they happen to encounter" [33].

Consequently, memory is the lengthy existence of traces of a fast stimulation or irritation in a group of neurons which left the communication and feed-back tracts in a corresponding closed oscillation circuit of the nerves.

That the memory traces in man can be artificially revived in the form of images from the remote past by a verbal irritant was vividly illustrated by Dr. L. Kompaneyets' practice of therapeutic hypnosis (Moscow, 1954). The woman patient M, 63, was hypnotized. It was "suggested" to the old lady that she was eight years old. Asked by the physician if she could read and write, the patient said she was attending the first grade. When the physician suggested that she open her eyes and write on a sheet of paper her name, surname and the word "departure," she wrote in large childish letters her name, surname, which in her childhood was "Luba Mal'tseva," and the word "departure" which she spelled with the letter Ъ, according to the orthography in use at the time of her childhood. (That letter was dropped from the Russian alphabet shortly after the Revolution.--Trans.). The doctor awakened her and again suggested that she write her name, surname the word "departure." The patient first remarked that "she could not write without her glasses," and when she put them on she wrote the word "departure" (with an apostrophe, that is without the previously used letter Ъ), as well as her Christian, patronymic and surname: "Lubov Alekseyevna M". (last name illegible). The patient was very surprised when she was shown her writing under hypnosis. Worthy of attention here is another remarkable fact: in the first case the patient did not require any glasses to write those words (she had not worn them in her childhood), and in the second case she could not do without the glasses (see Fig. 17).

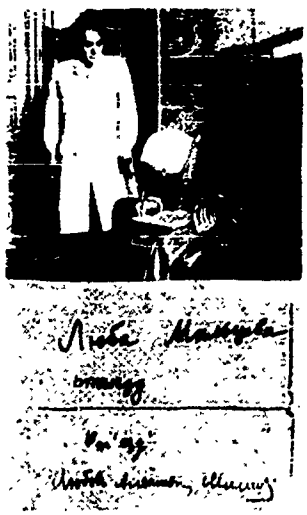

Fig. 17. A test involving the hypnotic restoration of events and words of childhood years to the memory of an elderly person.

a. Luba Mal'tseva b. departure (old spelling) c. departure (new spelling)
d. Lubov' Alekscyevna Mal'tseva (last name illegible)

This brings up a question which we will address to the medical specialists: if the sharp eyesight characteristic of youth could be restored temporarily to a middle-aged person, would it not be possible to develop a method (involving hypnotism) for at least a partial restoration of the deteriorated eyesight? It may be suggested beforehand that this is probably possible only when the visual organ of the middle-aged person has not suffered any irreversible change in the normal physiological condition the major component of this organ.

Another assumption It is possible that the lost acuity of sensory perception by other organically undamaged receptors (auditory, olfactory, taste and touch) could also be restored (fully or partially), by the use of a similar method of treatment (involving hypnosis).

Such a development of hypnotic therapy methods, it seems to us, would facilitate an unprecedented progress of medicine in an entirely new field.

Neurons and a Telegraph Cable

Let us return to the subject of our discussion, after this short digression. We have already pointed out that the Thompson oscillation circuit consists of two halves, two neuron tracts: centripetal and centrifugal. Originating at the particular point of the nervous system periphery (for example in the sensitive cutaneous tactile corpuscle at the end of the finger, in the olfaction bulb, in the capillary cell of the ear, in the epithelial cell of the retina, in the taste buds of the mucuous membrane of the tongue, etc.), these two neuron tracts function as follows: the first of them conducts the intercepted irritation (stimulation) to a point in the cortex which is cerebral end of the analyzers; the second leads the impulse-"command" from the cortex to the peripheral point. If the stimulation originates in the branches of the "axial cylinder" ganglion cell on the periphery, it follows in a centripetal direction. If the stimulation (in this case the impulse-"command") originated in the branch endings of the ganglion cell, it follows in a centrifugal direction.

That means that nest to the first (centripetal) neurite in the "telegraph cable" which, according to Leontovich, carries the stimulation to the center, there must be another neurite, a centrifugal one, carrying the impulse from the center; this "makes possible the exact distribution of our muscular efforts among the intended muscles or even bundles of muscles," to which the impulse-"command" is directed from our consciousness (the center).

There is another important aspect of this problem. A great number of various combinations of associated connections between the anatomically separated cerebral ends of the analyzers is possible in the human cortex during the thinking process. We have no way of knowing between which of the 14 billion brain cells temporary association occurs. But any object or person seen once, or a word heard once leaves a trace in these associative connections. Stored in the memory of every one of us are numerous occurrences of our lives, and if we only "strain" our will, (that is create a corresponding volutional impulse), the corresponding fact, object,

person, picture, action, word, etc., will "reappear" in our memory, occasionally even involuntarily.

Attempts are being made to solve that problem. P.I. Gulyayev, doctor of biological sciences, who had worked with Academician A.A. Ukhtomskiy, cites [27] two hypotheses worked out by the foreign authors Hubb and Milner. According to Hubb, a stimulation in the cortex produces a peculiar concentration of active nerve cells, the degree of their activity constantly changing. The cortex is thus divided into active and idle areas. The active brain appears to pulsate. The situation, however, is different, according to Milner's theory. The stimulation process enhances the activity of only the nerve cells found in the center of the concentrations. The neurons located around the edges are at the same time subjected to an inhibition process. Their "activity over," the active areas become more inert, and the state of stimulation is transferred to the neighboring passive areas. Unlike the first cast, the stimulation appears to be "running along the cortex."

To evaluate the provability of these two hypotheses, Dr. Gulyayev cites the result of checking them with cybernetic machines. In one case such a machine was built according to the Hubb hypothesis, and in the other according to Milner. At first the electronic scheme was based on Hubb's hypothesis. But a checkup failed to support his assumptions. The next scheme was designed according to Milner. This actually revealed the concentration of active and passive neurons, and the stimulating wave appeared to be moving along the cortex."

A curious natural scientist would inevitably want to know whether the human central nervous system contains a physiological apparatus, a "regulator," that deals with the changes in the thermal molecular movements and nuclear electromagnetic vibrations of the cerebral nerve particles in the process of thinking; and if there is one, where is it located and how does it function?

To answer this question would amount to solving the mystery of how matter -- brain -- thinks. "There was a time," A.V. Leontovich writes, "when they used to

...

localize the higher psychic functions in the frontal lobes of the brain. That fitted in with the then existing theory that these lobes are much more developed in man and monkeys than in other animals. More accurate observations revealed, however, that considerable damage to the frontal lobes in man frequently failed to produce any changes in his phyche. The following attempt in this direction was made by Flexig, a famous German psychiatrist. He found in the posterior portions of the frontal lobes as well as in the temporal lobes so-called "associative centers" which, when damaged, allegedly produced a sharp change in the nature of the patient as well as certain other psychic changes.

"But Flexig's work has so far not been fully substantiated, and I.P. Pavlov rejected it altogether on the basis of his own conditioned reflex methods...It appears that these functions are localized in individual brain areas and gyri (convolutions) but are more or less diffused in the cerebral cortex which greatly complicates their study."

Going back to Fig. 5 which shows the diagram of the sensitive and motor tracts (according to Ramon-y-Cajal), we see that these tracts cross each other in the medulla oblongata. This naturally brings up the question: is it the medulla oblongata, which closely adjoins the cerebellum and even adheres to it in one place, the location of the endings of the associated cerebellum nerve tracts representing the mentioned "regulator," that is, the device which, in the technical sense of the word, deals with the changing thermal movements of the cerebral nerve particles in the process of thinking? We are familiar with the role of the medulla oblongata in the regulation of the myogenic tonus from the textbook of physiology [16]. But we also know that the major function of the cerebellum, which is an organ of equilibrium, is the coordination of movements, that is the control of the muscular tissue impulses.

The assumption of such a possibility is justified by the following considerations based on some experiments with a live human brain. The chiasma of the nerve tracts in the medulla oblongata, which looks like a narrow isthmus, is the place

where all or almost all nerve tracts meet or come fairly close to one another. What is conspicuous here is the very economical structure of the nerves themselves. It may be assumed that the unknown "regulation" device, A.V. Leontovich's opinion to the contrary notwithstanding, is not "diffused" over a large area of the cerebral cortex but concentrated within a relatively limited space in the cerebellum and medulla oblongata. This would make the cerebellum the center of that "regulating" device, and its nerve ending penetrating deep into the substance of the medulla oblongata would be the peripheral apparatuses of the center's inductive functions.

An original characteristic of the medulla oblongata is the so-called "reticular substance" (formatio reticularis) consisting of numerous closely interwoven fibers extending in three intersecting directions and forming a dense bed with niches containing associative type ganglion nerve cells. As is known, the medulla oblongata forms a number of independent centers (centers of cardiac and respiratory activity, a vasomotorial center and a center regulating the metabolic processes). According to Leontovich, this multiplicity of centers is explained by the development of a "reticular substance" which binds the various nerves and cells of the medulla oblongata into something resembling an organ. Might we not assume, however, that in addition to the mechanical role of such a bond, that is the cohesion of the various nerves and cells among each other, the "organoid reticular substance" represents the particular zone of the medulla oblongata where the converging nerve conductors are subjected to the inductive effect of the cerebellum end apparatuses? Viewed from this angle, the "reticular substance" is a receptacle of the peripheral nerve apparatuses of the cerebellum, that is an organ controlling (by the will of man or involuntarily) the changing thermal movements of the nerve substances in the brain in the process of thinking.

The research work by Denny--Brown and W. Russett [29] on the consequences of traumatic shock caused by experimentally produced brain concussion was published in 1941. The authors came to the conclusion that a mechanical blow on the head with a certain force resulting in brain concussion paralyzes all the bulbar-reflex

mechanisms (the word "bulbar," from the Latin bulbus, is occasionally used to designate the medulla oblongata as independent of the brain). In addition to an obvious blackout of the mind, which also means a repression of the thinking processes, it also reveals the following symptoms: irregular restoration and certain motor effects on the body and the limbs. The duration of the paralysis is directly proportional to the force of the shock. The occurrence of the vagus nerve is predominant in a light shock. The full restoration of consciousness occurs two-four minutes later (after the blow). A heavy shock is followed by a sharp and irreversible drop in blood pressure, 20-400 seconds after the blow, a sharp constriction of the peripheral blood vessels and an accelerated pulse -- and the result is fatal.

These experiments proved that the causes of all these disorders are the shock-produced powerful irritation of the special (depressive) nerves where they enter the medulla oblongata, and the stimulation of the special (vagoglosso-pharyngeal) system in the medulla oblongata. In other words, what we see here is not necessarily a "mechanical" damage to the tissue of particular nerves but a special effect produced by certain nerves which is rather comparable to a trauma of a psychic order. Consequently, this effect is after all a function of certain nerves acting as a "regulator" of some kind. It is quite possible to assume that, as a product of a mechanical irritation (from a blow), this effect manifests itself in a purely inductive way. Our point of view justifies the assumption that the special effect of the extreme phase of the mechanical irritation of the depressive nerves (in case of shock) revealed the effect of their inductive influence on the associative type ganglion nerve cells found in the niches of the "reticular substance" body. Such an inductive effect changed the nature of the thermal movements of the nerve particles in the medulla oblongata and the cerebellum as well as the large hemispheres including the cortex. The normal control over the thermal movements of the nerve particles in the brain (in the process of thinking) prior to the shcok, are replaced during the shock by a sharp and considerably inductive effect

of the depressive nerves (and the vago-glosso-pharyngeal apparatus) and the result is a change in all the parameters of this thermal movement: speed, the distance covered by each particle and the impulse force of its movement. But if the mentioned change of the parameters of thermal movement occurs under the influence of some external effect (in this case, the irritation of the depressive nerves and the stimulation of the vago-glosso-pharyngeal system), it very possibly is the result of the inductive influence of the peripheral ends of the associative nerves of the cerebellum contained in the niches of the "organoid reticular substance" of the medulla oblongata, or the effect of the impulses of the "regulating" device of the cerebellum and medulla oblongata in the normal act of thinking.

Reflex Arches

Deduction. All the cortical cells involved in the process of thinking, being inductively combined with the associative nerve fibers into a single functional whole, are subordinated to some single group of cells (of central significance, in this case) of the cerebellum and medulla oblongata. Thus, according to our hypothesis, the force of the volitional impulse may have something to do with the "supreme" control over the psychic functions of thinking brain matter.

The human process of thinking affects the intramolecular movements and vibrations of the generating brain particles by man's volition (or involuntarily) which controls these movements, for example, by the inductive "regulating" apparatus of the cerebellum and the "organoid reticular substance" of the medulla oblongata. This changes the movement and regroups the particles. The thinking process occurs in the course of this intramolecular regrouping: we perceive new thoughts, ideas, images, complex pictures and experiences, at the same time emitting radiation accompanying this thinking process. The generating and thinking processes are organically interconnected and the transmission of a "thought wave," or telepathema, is characterized by the same changes in the oscillations that are occurring in the generating particles of the brain.

However, participating in the transmission of mental information, and, I should say, all psychic acts over a distance are not only the generating brain particles but also the "reflex arches" connecting the peripheral nerve elements of a particular receptor organ with the cerebral end of the analyzer and thereby forming a live Thompson oscillation vibrator-circuit . If these vibrators are capable of emitting the familiar bio-electromagnetic waves, then the generating brain particles should be ascribed the role of cellular molecular generators emitting bio-radiation waves of a still undisclosed quantum nature.

Whenever the nerve vibrators in the human organism function at the subconscious level of the brain, the emission of bio-electromagnetic waves that occurs at the time may be conditionally referred to as a lower class of radiation. These include the emissions of our nerve elements comprising the complex "reflex arch" of our sense organ, as well as the necrobiotic waves (see section "But I am not alone!). By the term "lower class," we should like to separate the concept of the other type of waves radiated by the nerve vibrators as they function at the subconscious brain level. The latter radiation should in turn be divided into two classes: medium and high. The medium class may include bio-electromagnetic waves accompanying the functions of the sense organs, recorded in our consciousness, without the participation of the thinking process. In the higher class we may conditionally include the same functions of the sense organs, accompanied by the process of thinking, as well as the act of thinking itself without the function of the sense organs. The higher class of the bio-radiation communication among people also includes the already mentioned "bio radio psychic" function of the third signal system.

Memory Storage

In conclusion, we shall cite some comparisons between the thinking brain "mechanisms" and electronic computers and cybernetic machines. Assuming that various combinations of associative communication of a psychic nature, so to speak, could be established among the 14 billion cerebral nerve cells, the resulting

number of such combinations would be expressed by the astronomical figure of 10^{10000}. Is it not possible that this large number of possible connections between the cerebral neuron cells explains our capacity for memorizing and recalling innumerable facts of the past? Do the different combinations of these connections between the cells, or each cell within such combinations, play the part of a "memory storage"?

But even the most perfect electronic computer or cybernetic machine cannot be compared to the brain which is more complex and more perfect. The electronic computing machine which precipitated a true revolution in science has a memory device which is also referred to as "memory." The machine has an operational and magnetic memorizing device. But we must not assume that there is anything in common between these devices and human memory. The machine can "memorize" a given mathematical and other program, words, grammatical rules for translation from one language into another, etc., but this "memorization" is a purely mechanical process. Automation and machinery have been adapted even to the logical process. Everyone knows that a photograph is an object recorded through the use of a camera, or that the phonograph record and sound recording tape "memorizes" the sounds recorded on it. A computing machine using a similar "memory" in the performance of logical operations, does it automatically and, of course, cannot "consciously" analyze or synthesize the recording. It merely performs every part of a man-assigned program but cannot replace memory, much less human consciousness.

This is admitted also by the American scientist N. Wiener, one of the founders of cybernetics. In his lecture on "Cerebral Waves and Self-organizing Systems" (read on June 1960 in the State Polytechnical Museum of Moscow), he referred to the brain as a kind of self-controlling computing machine, but emphasized that the further we study the human brain as a self-organizing system, the more clearly will we see the superiority of this system to any computing-analytical machine.

The American scientists calculated that the electronic communication facilities of a computing machine (electron-beam tubes, tubes, wires, contacts and other parts of a theoretically perfect machine), capable of producing the same number of communication and information combinations as the human brain, would occupy a space equal to the territory of the state of New York, and the electric power required to operate such a computer would be equal to that of the entire system of hydroelectric powers of Niagara Falls.

The above-cited comparisons provide only an inkling of the huge gap existing between the nature-created human brain, as an "apparatus" for biological radio communication, and the man-created electronic devices of technical radio communication, computing and cybernetic machines. But this gap also shows how enormous are the possibilities now arising before the curious human mind, and that is the achievement of increasingly more perfect methods of radio communication, including its highest form, biological radio communication.

CHAPTER VI

K.E. TSIOLKOVSKIY ON TELEPATHY

Attending the All-Russian Congress of the Naturalist Association (ASSNAT) where I reported on my hypothesis "Thought-an electromagnetic wave," I first met K.E. Tsiolkovskiy who had arrived from Kaluga. He submitted two reports to the Congress: On an old metal dirigible and a cosmic rocket. I talked to him during the intermissions. Tsiolkovskiy displayed a lively interest in the hypothesis of the electromagnetic nature of the transmission of mental information over a distance.

After Tsiolkovskiy's return to Kaluga, we started a lively correspondence on a variety of scientific and technical problems. K.E. Tsiolkovskiy sent me the following comment on my hypothesis: "There can be no doubt about the existence of telepathic phenomena. First, voluminous factual material is available on the subject, and, second, practically every family man might be able to report on personal telepathic experiences. An attempt to explain them from a scientific point of view is worthy of consideration. Such an attempt is being made by B.B. Kazhinskiy. He compares the human nervous system with radio telegraphy. He also indentifies the corresponding organs in the body of an animal.

There appears to be one contrediction in this theory. Stimulation travels along the nerves at a speed of 30 meters per second. And as the nerve apparatus is after all made up of similar elements, or rather of the same material, the speed of thought should be unlimited, that is we would be thinking millions of times faster than is actually the case. But the point is that the chemical activity in the nerves which spreads very slowly and comprises ordinary thought, is accompanied by a stimulation of electromagnetic waves propagate at the speed of light. The latter produce an effect on similarly tuned nervous systems of people close to us, and produce certain telepathic phenomena.

Let me cite an analogy. Imagine two observers standing at the opposite ends of a long cast-iron pipe filled with water. One of them hits the pipe with a

hammer; a little while later the other will hear three different strokes, the sound will first reach him through the pipe, then through the water and finally through the air. If the sound in the air travelled 40 seconds, the sound wave in the water travelled only 10 seconds and in the cast-iron four seconds. But the hammer blow also produced heat, light and electricity which could also be manifested in electromagnetic waves travelling hundreds of times faster than the sound waves. Do we not see something similar occurring in the nervous system combinations? B.B. Kazhinskiy, it seems, finds support for his idea in experiments with animals."

Ten years later (in May 1933) I had occasion to visit Tsiolkovskiy in Kaluga. We spent many hours in heart-to-heart talks.

I remember being fascinated by what Tsiolkovskiy said after he had heard my story of the theory of biological communication. He said: "It is in the coming century of aeronautics that human telepathic capacities will be urgently needed, and will serve the general progress of mankind. You and I may be called brothers in spirit, people holding the same views. While my cosmic rocket can and should lead to the solution of the great mysteries of the macrocosm, your theory may result in the solution of the sacred mysteries of the live microcosm, to the solution of the great riddle surrounding the thinking brain matter. But the macrocosm and microcosm are parts of a single nature of the universe. The solution of the riddle of the microcosm promises truly great achievements for mankind, probably not less than the cosmic rocket."

In another conversation I remarked: there is feeling among scientists that the transmission of mental information over a distance is a supernatural capacity of certain people which has nothing in common with the natural patterns established by science. What do you think of this opinion?

Tsiolkovskiy retorted facetiously

"It is either one of the other, you know: if these scientists believe that such a capacity actually exists in people, they actually have no right to call it supernatural. In this case, their error should be called to their attention.

Everything that exists in nature is precisely what we call natural, that is natural for the nature as we understand it. That is point No. 1. The second point is that if these scientists, contradicting their own logic, are inclined to believe a certain natural phenomenon to be supernatural, it means that they are simply incompetent and their opinion should be disregarded as unscientific."

What then can be done?, I asked.

"You must bear in mind that every thing that is new, advanced and progressive is almost always resisted by the followers of the old concepts. I am speaking from personal experience: the bolder the idea revealing surprising future prospects, the more desperate the resistance offered by the obscurantists acting under cover of science. Do not hesitate to accept any fight, keep working and experimenting. You are on the right track. Blaze a new trail for your idea leading to the victory of the people, science and life."

Professor Ivantsov's Doubts

Let us look into the objections made by the opponents of the hypothesis of a biological radio communication. Let us go back to the time of the heated debates and discussions on this problem. March 1924. Professor N.A. Ivantsov read a report on the "Electromagnetic theory of thought transference"[1] in the Zoological Auditorium of the Moscow Lomonosov University. The speaker gave a critical review of the theses advanced in my book [36]. Here is what he said.

1. Kazhinskiy looks upon the nervous system as a closed Thompson oscillation circuit. But the nerve branches terminate on one side in the brain centers, and on the other on the periphery in the muscles, skin and sense organs. Thus the nerve tract is neither ring-shaped nor closed.

2. The mental electromagnetic waves must go through the cranium cover of those who emit them and those who perceive them. It is quite possible to assume that in view of its high electric resistance, the cranium is a kind of insulator against electromagnetic waves.

3. Using his own scheme of the nerve tract as an analogy of such a vibrator as the Thompson oscillation circuit, the other makes no mention of the possible emissions from the ganglion brain cells, according to Lazarev and Bekhterev.

4. Even if we assume the formation of electromagnetic oscillations in the brain, we must anticipate that they would produce similar oscillations in the other nerve tracts of the brain, inductively, and result in a confusion in the head, which does not, in effect, exist.

5. There are no grounds at all for this hypothesis. Even if we look upon the neuron dendrites as condensers and the neuron windings as those of a solenoid, as the author does, or the ganglion brain cells as generators of electromagnetic waves, as is done by this and others, it would still be impossible to explain the transfer of thought as images because it is possible to explain the transmission of these waves only as signals. There is no ground for the assumption that each individual cell emits its own particular type of wave. There are no nerve apparatuses in the brain capable of emitting a complex wave.

6. Inasmuch as the nerve elements referred to by the author are the same in all people, the telepathic phenomena would be perceived by all of them in the same way. But the percipients of telepathic transmission are rare individuals, that is they are an exception to the general rule. Why do not the vast majority of people receive anything from one another even from a very short distance?

7. The Krause bulbs only serve the olfactory sense and cannot be used for thought transference. It would look absurd if the sole of the foot were able to perceive the image of an electric bulb, for example.

8. The author considers the hair as antennas. In this case, bald headed people cannot transmit or receive thoughts from a distance.

9. V.M. Bekhterev's experiments with V.L. Durov's dogs are not convincing. When I met Bekhterev at Durov's in 1922 I heard him say that one successful test in this area would allegedly be of decisive importance. We know that experimentere working in other fields of science have an entirely different opinion.

10. We know that telepathic transmissions involve the perception of images of trees and other objects, in addition to human images. But a tree cannot radiate electromagnetic waves. How can this contradiction be reconciled?

11. It is not clear how that dog, seeing only the experimenter's eyes, could find the book he was mentally ordered to.

12. The successful experiments with Durov's trained animals in his laboratory and circus work can be explained only by the unique capacity of the animals to intercept signals that are invisible and inaudible to people, signals of which even the experimenter himself is unconscious and which guide the dogs in their rehearsed movements and actions.

13. The electromagnetic hypothesis of thought transference to animals does not meet the scientific requirements.

My Rebuttal

I was given the floor after that report. Following a brief outline of my replies to my opponent's arguments listed above.

1. By refuting certain individual theses of my book, the speaker deliberately made no reference to other thesis with which he is either in agreement (and therefore fails to mention them), or he disagrees with them but is unable to refute them. Thus by criticizing my interpretation of the nerve tract (consisting of several neurons with solenoid windings and condenser armatures) as a closed Thompson oscillation circuit, the speaker failed to mention that my hypothesis also assumes the existence of an open nerve tract designed like the open vibrator which is well-known in radio engineering.

2. Comparing the cranium to an "insulator" against electromagnetic oscillations, the speaker either forgot or does not know that only a box or a closed shell with current-conducting walls can serve as such an "insulator" or device; this is the principle of the Faraday Cage which is well-known in physics. Inasmuch as the speaker himself claims that the cranium does not conduct electricity, it cannot produce the effect of a Faraday cage, that is it is not a screen that can block the electromagnetic waves.

3. The work of Academicians Lazarev and Bekhterev, mentioned by the speaker, was designed to prove the presence in the human nervous system of elements that play the part of vibrators and generators of electromagnetic waves, and in this respect deserves full recognition. For the purpose of my book, however, I found it more important to develop only the assumptions that have long since been dealt with in my analogies. This should be particularly clear since the assumptions made by both Academicians did not contain any concrete schemes. Here I must stipulate that in his explanation of the electromagnetic field as resulting from [illegible] motor or sensory act originating in the human mind, Academician Lazarev attributes that phenomenon only to such causes as the periodic pulsation of two parallel procedures: the chemical process of decomposing the cell substance in the center of the brain and the electromotive force developing in the brain cells. Here Lazarev also assigns an important role to the ionization process of the cell substance.

But we must take this explanation as indirect and approximate, because, on the one hand, the function of the ganglion cell as a generator of an electromagnetic wave is not quite clear, and, on the other, the explanation offers no concrete description of the formation of electromagnetic oscillations in the cell. Nor is it clear why the axial cylinders and dendrites extending from the cell are left out of the overall function of the cell as a wave generator. Unlike Lazarev, Academician Bekhterev believes that electromagnetic oscillations originate not only in the cortex but also in the nerves which act as conductors, that is he goes further than Academician Lazarev. But Bekhterev, unfortunately, also fails to provide an exhaustive and concrete scheme of action of this system of vibrators and generators. That is why I consider the discussion of these circumstances in my book premature and unnecessary.

4. It is not clear why the speaker insists that the cerebral electromagnetic waves do not affect the brain emitting them. This is like claiming that the waves emitted from a radio station do not affect the performance of the apparatuses in that station. It would be more correct to assume that the wave of one cell in

the brain is damped (attenuated) by a more intensive performance of another nerve cell in the same brain, and this cannot produce any "confusion" in the brain.

5. The connection between the subjective psychic process in the brain with the electric phenomena in the nervous system of the same organism has been proved, and it is manifested not in connection with individual elements of the nervous system but as a complex involving all the elements of the nervous system. This is precisely why the speaker's opinion can be countered by the fact that the waves emitted by the human nervous system in the process of thinking must correspond to the total molecular processes which are intricately connected with the psychic function of the brain. What is radiated from the organism is not an individual wave characteristic of each individual cell, but a complex wave, and the result is not a "confusion" of scattered individual signals but a combination comprising an image, picture or other presentation corresponding to the work of the radiating brain at a given moment.

6. The speaker was wrong when he refuted the fact of thought transference for the sole reason that such transmissions are not intercepted equally by all people. If an electromagnetic wave carrying mental information or sensation, images, etc., from one person is to be perceived by another person, a number of favorable conditions is required and these seldom occur simultaneously. That is why the actual cases of transmission of mental information seldom become known. This is one reason why the majority of scientists still view telepathic phenomena with distrust and prejudice, while some of them consider them to be mysterious or supernatural phenomena. It is time to remove the aura of mystery from these phenomena and subject them to an objective scientific analysis. Unfortunately, reports of the kind delivered today do not serve such a worthy cause.

7. The speaker is mistaken when he considers my comparisons between the other elements of the nervous system with the components of radio stations as final. The Krause bulbs, for example, represent the same rightful attempt to consider a given element from the point of view of the physics of radio communication,

just like the other attempts listed in my book. The reason I compared that element with a receiving antenna loop is because these nerve elements are located primarily on the periphery of the nervous system. I never claimed in my book, as the speaker is trying to prove, that these elements are allegedly designed to record intercepted thoughts. The point is that in radio engineering, the antenna merely intercepts the incoming electromagnetic waves which are recorded by a different device.

8. The scheme portrayed in my book may lend itself to the erroneous deduction that the hair on the head represents a kind of antenna. Of course, there is no support for such an "analogy" in the human organism. But the speaker and a few others here took this occasion to poke mild fun at such an "analogy." This case has to do with topographic and not organic analogy. It is not ruled out that the epithelial nerve ends, the olfactory organ "fila," can take the part of an antenna of a closed oscillation circuit of the olfactory nerve tract. By the same token, the nerve cell "fila" in the cochlea could serve as a microantenna of a closed oscillation circuit of the auditory nerve tract. There is a certain similarity between antennas and the tentacle feelers of some insects, particularly bees, caterpillars and butterflies.

9. Bekhterev's experiments with Durov's trained dogs should not be considered unconvincing. The speaker tries to explain the successful transmission of mental assignments to Durov's dogs merely as the capacity of the animal to be guided by its foresight and the somatic movements of the experimenter. The speaker does not know all the details of Durov's remarkable experiments, otherwise he would not argue the point.

10. Durov's successful experiments with dogs proved that telepathic transmissions result in the perception of images and pictures of objects even though they themselves do not emit electromagnetic waves but are merely part of the transmitted image. This circumstance represents a proof rather than a reason for rejecting the electromagnetic hypothesis as the speaker is trying to do.

11. What the dog intercepts in her mind is not the picture of the experimenter's eyes but a mentally suggested image, sensation, etc. Durov developed the methods for such suggestions which are associated with the animal's emotional reflexes. That is why people unfamiliar with these methods are unable to make any mental suggestions to Durov's dogs. But Bekhterev and his colleagues who had studied Durov's methods and have the gift of suggestion were successful in these experiments.

But I Am Not Alone!

Professor N.A. Ivantsov's views were also disputed by professors G.A. Kozhevnikov and A.V. Leontovich. A.V. Leontovich referred in his statement to the speaker's criticism of Kazhinskiy claim that the nerves represented a closed circuit. But such an authority on physiology as the late A.S. Dogel' also believed that the nerves represented a closed system (here, by way of example, professor A.V. Leontovich demonstrated with chalk on a blackboard the scheme of a Grandri nerve corpuscle, according to Dogel'). Ya.N. Zhuk's experiments[2] had convinced professor Leontovich of certain factors indicating the existence of some kind of thought transference, and he therefore did not consider Kazhinskiy's idea as a fantasy allegedly not worthy of experimental verification. On the contrary, he was convinced that Kazhinskiy's hypothesis warranted an all-sided and painstaking experimental verification.

Professor V.K. Arkad'yev said that inasmuch as science recognizes the existences of different electric potentials in the human nervous system, measured in thousands of a volt and less, there is reason to assume the emission of electromagnetic waves by the human nervous system. If we only knew the period of those emissions, regardless of their insignificant force, we could find the method of recording and determining their characteristics such as the wave length emitted by the human brain in the course of thinking, for example. Such experiments are possible. All that is needed in order to carry them out according to a definite plan is a working hypothesis, similar to the one proposed by Kazhinskiy, for example.

Eventually Arkad'yev published his theoretical calculation (1) of the magnitudes of the electric and electromagnetic fields that may appear in the space surrounding a thinking subject. According to his calculations, the force of the magnetic field does not exceed 10^{-15} Gauss, in other words it is too small and therefore cannot be measured by the available measuring devices. In Arkad'yev's opinion, the electromagnetic energy in this case equals 6.54×10^{-24} erg, that is several thousand times less than the energy perceivable by the most sensitive human organ, the eye (2×10^{-10} erg.). His calculations led him to the conclusion that "the magnitudes of the field or force of the current involved in either case are too insignificant to produce any effect." Moreover, my hypothesis was supported by the experiments on people carried out over a period of 16 months (1922-1923) in the Leningrad section of Mental Suggestion of the Society of Neurology, Reflexology and Biological Physics organized by Academician V.M. Bekhterev in the Reflexological Institute for Brain Studies. Professor V.A. Poderni, a physicist, was in charge of the experiments. We shall cite the conclusions from his January 1924 report to the Second Congress of Neuropsychiatrists in Leningrad. The experiments confirmed the fact of transmission of mental (visual) images and emotional states as well as motor impulses from one brain to another over a distance. There were recorded instances when the percipient intercepted impulses from the subconscious activity of a particular peripheral sense organ, that is the eyes, ear, etc.," formed in the inductor's brain. The method of studying these phenomena, referred to as receptor induction, adopted by the Section, made it possible to establish the conditions for a successful transmission of impulses from the inductor over a distance, and the conditions for the reception by the percipient of these impulses, thereby stimulating in his mind corresponding mental images and sensations. Further, it was found possible to artificially postpone the emergence of mental images and sensations received by the pericipient's brain (from the inductor) to a predetermined moment. It was proved experimentally that the image-sensation received by the percipient first emerges in his subconscious sphere, and

is then formed in his consciousness. It was established that a successful experiment in the transmission-reception of mental information over a distance requires that the subconscious sphere of the percipient is not in a stimulated state during the experiment.

Speaking at the same Congress, professor L.L. Vasil'yev, a neurologist, reported on his experimental research at the Reflexocological Institute to establish the effect of a magnet on the percipients reception of mental suggestion from the inductor [17]. A large horseshoe-shaped magnet capable of lifting 1.6 kilograms, was placed about 5 centimeters from the occipital side of the head so that it did not touch the hair. During the experiments the percipient did not know when and how the magnet was applied. It was found that the magnet was effective only when one of its poles was exactly opposite the right half of the head, and the other the left half. The percipient was able to receive a suggestion when the north pole of the magnet was facing the left half of the head. When the poles were reversed, the suggestion could not be received. These experiments show the effect of the magnetic field on the passage of the nerve processes in the human cortex. In particular, it was suggested to a hypnotized person that he saw a certain visual image, picture, figure. He actually claimed that he "saw" all that. It should be emphasized that the visual sensation of the suggested figure occurred in the brain of the hypnotized person, or in the optic lobes of his cortex, to be exact. In this case the transmission of a given optic sensation to the brain from the light-sensitive layer of the eye retina, as the hypnotized man's optic receptor, was out of the question. But when the magnet held up to the occipital part of the hypnotized subject's head was slightly shifted to the side, the figure perceived by his brain was also shifted and distorted (according to the hypnotized subject).

No explanation for these "strange" phenomena could be found at that time. It was only recently (in 1959) that a group of Soviet scientists working in the laboratory of the Institute of Chemical Physics of the USSR Academy of Sciences under doctor of chemical sciences L.A. Blumenfel'd, made it possible to find that

explanation. It was formerly believed that magnetism is possible only in crystalline material containing metal, such as iron, nickel and cobalt, with free unpaired electrons (these metal properties are known as ferromagnetic[4]). According to this view, it was believed that the live tissue of an organism did not possess any magnetic properties. But that view is now obsolete. The mentioned Soviet researches established that free, that is unpaired, electrons also appear in an albumin molecule during a chemical reaction. They are found also in the so-called desoxyribonucleic acid (which we shall hereafter call nucleic acid, i.e. DNA, for simplicity) representing a chemical substance from which the nucleus of a live cell is formed.

When an examination was made of not only pure nucleic acid but also the portions of the nerve tissue containing large quantities of that acid (parts of the cortex, the cerebellum, etc.), they were also found to be magnetic. It should be noted that nucleic acid also plays a major part in the chomosome transmission of hereditary characteristics from parent to progeny.

Following the Soviet scientist L.A. Blumenfel'd, what looked like ferromagnetic properties of nucleic acid was experimentally confirmed (in 1960) also by the French scientists Sadron, Duzu and Polonskiy. They established that in addition to magnetic properties, nucleic acid also possesses electric properties. This led to the important conclusion that nucleic acid possesses also electromagnetic properties. There is an assumption that this substance, found in both the chromosome and the nucleus of a nerve cell, looks like a relatively elongated and twisted fiber "flagelleum" and behaves exactly like the tape of a magnetic sound recorder. Under the effect of electromagnetic oscillations produced by the impulse of the brain's psychic function, the atomic groups comprising that fiber arrange themselves during the reception of a particular type of information in such a way as to produce an effect similar to the magnetic effect on a sound recorder tape.

Moreover, the appearance in even the facial feature of the future progeny, its memory elements as well as behavior patterns seem to be recorded on the nucleic acid fiber of the progenitor's chromosomes in the form of particular electromagnetic variations. A further development of this thesis brings us to a substantiated conclusion: the diversified information transmitted to the brain of an adult individual by his sense organs is stored in the nucleic acid molecules of the nerve cell nucleus in the cortex, as in memory cells. After being "processed" by an analysis and synthesis of the organs of consciousness, this information remains in the "flagella," brain memory cells, or unique "storage places," until a volutional impulse-order from the brain returns the information to the sphere of consciousness whenever it becomes necessary.

From this we may draw one more important conclusion for the theory of biological radio communication; at the time the information received in the conscious sphere is "processed" by analysis and synthesis in the nerve cell nucleus of the human brain, the radiation emanating from that cell carries waves representing the physical agent accompanying the formation of that psychic information in the brain. These waves are the stimulating agents which, when reaching the nerve cell nucleus in the brain of another person (who may even happen to be far away), produce an effect on that nucleus according to the laws of induction and resonance. The result is an irritation of the corresponding nucleus in the other brain activating its psychic activity which is entirely similar to the work of the first brain.

The discovery of magnetic and electromagnetic properties of nucleic acid in the cells of our nervous system (and in the chromosomes) should be considered as the opening of a new field which may lead to other important discoveries amounting to a revolution in science and the life of mankind which will rank in importance with the researches into the structure of the atomic nucleus and the cosmic rockets that have already revolutionized science and life. Reporting on these prospects, the president of the Paris Academy of Sciences, F. Perren, said (on 9 May 1960); "I believe that the scientific discovery I have just told you about will blaze a trail

to the understanding of the basic laws and mechanisms controlling living matter."

The newspaper Humanite (May 1960) referred to this discovery as portending a basic change in science and the life of mankind, a change no less important than the nuclear researches and cosmic rockets which have revolutionized science and life.

These significant conclusions of contemporary science are directly related to the biological radio communication in the animal kingdom, including the phenomena of thought transference over a distance among people. The words that were uttered on 9 May 1960 in the Paris Academy of Sciences by F. Perren have something in common with those said by K.E. Tsiolkovskiy on 20 May 1933 in Kaluga to the effect that the theory of biological radio communication "may lead to the solution of the sacred mysteries of the living microcosm, to the solution of the great riddle of the thinking brain matter."

Worthy of attention also are some of the considerations voiced by the Soviet scientists D.M. Spitkovskiy, P.I. Tseytlin and V.S. Tongur (1960) who are engaged in the study of the morphological change of the nucleic acid fiber. Thus their investigations "indicate the approach to the understanding of the unique configurational consequences of nucleic acid when it is exposed to relatively low doses of penetrating radiation" (D.M. Spitkovskiy, P.I. Tseytlin, V.S. Tongur, On Two Configuration States of Nucleic Acid and Certain Related Phenomena, Biophysics, Vol. 5, First Edition, 1960, pp. 3-15). Developing the above-mentioned theme on the role of the fiber "flagellum" of nucleic acid in the psychic function of the brain cell, we come to another and just as important conclusion. The radiation emanating from the cell of one brain, having reached the zone of the other brain, proceeds to irradiate that brain, that is it affects it as a penetrating radiation which produces the "unique configurational consequences of the nucleic acid." This "after effect" produces exactly the same disposition of the atomic groups of the nucleic acid fiber in the cells of the other brain. The result of this incoming

penetrating radiation is what people usually call the transmission of mental information over a distance.

To this we must add that not only a particular nucleic acid "flagellum" of the nerve cell in the brain participates in such a transmission (and reception) of "mental" radiation, but also something else. We know from I.P. Pavlov's brilliant theory of the higher nervous activity that each sense organ (sensation receptor) is anatomically connected with the nerve tract and the corresponding "analyzer," the central apparatus of the cortex. It is through the analyzer that we get the information both from within our organism and from without; that information is processed in our brain by analysis and synthesis and emerges in the form of a particular thought.

The formation of electromagnetic oscillations in the cell substance (in the ganglion cells of the cortex), according to Academician P.P. Lazarev [43], is due to the chemical reaction of that substance to the stimulation of the nerve cell. This is how he approaches the determination of the wave length radiated by the nerve cell in the brain in the course of thinking: "Every sensation and every movement must produce long waves (up to 30,000 kilometers) in the surrounding medium. Just what physiological role these waves can play, it is difficult to say, but it is possible that they will help us explain the suggestion phenomenon and other more complicated phenomena in the psychic region...as the periodic electromotive force arising at a certain point in space must inevitably produce in the air medium an alternating electromagnetic field propagating at the speed of light; we must expect that every motor or sensory act of ours originating in the brain will emerge to the surrounding medium in the form of an electromagnetic wave."

Referring to V.L. Durov's experiments with the screening chamber built by me, Academician P.P. Lazarev said in 1923 that these experiments should be continued. He was still more specific ON this subject in 1939.

Academician P.P. Lazarev working together with Academician V.F. Mitkevich and hypnotist S.I. Kanaris, conducted three series of interesting experiments.

which proved the electromagnetic nature of mental suggestions to people under hypnosis. In a number of the experiments of the first series S.I. Kanaris conducted his hypnotic seances in the usual manner whereby the hypnotized person, falling into a trance, proceeded to carry out the mental suggestions. In another series of tests, when S.I. Kanaris placed a grounded metal semicircular object on his head, none of those present could be hypnotized. But as soon as the hypnotist removed the metal object from his head, the experiment was again successful. In a third series of tests, when a natural electromagnet was held up to the back of the hypnotist's head, he was unable to produce a hypnotic effect. As soon as the magnet was removed, the seance proceeded normally again. This served to confirm the results of professor L.L. Vasil'yev's (1924) showing the effect of a magnetic field on the passage of psychic processes in the human cortex.

It may be pointed out in passing that this scientist maintains the original view on the nature of telepathic phenomena. Believing these phenomena to be rare occurrences, he justly classifies among the most difficult and complex problems of psychoneurology. The capacity of the brain to intercept information from another brain over a distance (or as it is also called "a natural parapsychic gift") has, according to Vasil'yev, not been progressing but degenerating for thousands of years. This opinion is based on the fact that, first, such biological radio communication is more frequently manifested among animals than among people; second, this capacity among people is manifested as a rudimentary characteristic preserved from the zoological ancestors, and if it is occasionally revived it is mostly among nervous or psychologically inferior people in the form of a unique atavism. It is pointed out that while the biological justification of such radio communication in the animal kingdom may be connected with matters of vital importance (among butterflies, for example, it contributes to the preservation of the specie), it is no longer important among people from a biological point of view.

We believe that such an evaluation of biological radio communication does not in any way derogate from the problem itself nor minimize the importance of

studying it. It merely indicates the different approach to the problem which should be welcomed.

We will add something new to it. In 1960, a Czechoslovakian scientist, M. Ryzl [86], succeeded in obtaining experimental proof of the fact that it is possible to educate, train and develop the "telepathic" capacity of the human brain. This, of course, depends on whether people need such brain capacity. I for one agree with K.E. Tsiolkovskiy that such a capacity is urgently required for human progress now. I believe it will be useful in the coming age of communism on earth, in the age of development of space travel to other planets.

A.V. Leontovich's Work Supports the Theory of Biological Radio Communication

The reader will remember how cautious Academician A.V. Leontovich was at first about my analogies, and how long he avoided making any specific statements on the subject. But further investigations carried out by Academician A.V. Leontovich and his school into the phenomena of electromagnetic induction in the nervous system led to the establishment of the presence of a Thompson oscillation circuit in the nerve elements. In 1933 he wrote in one of his papers that "the nerve stimulation is transmitted from one neuron to another electrically, and mostly inductively, from the pericellular to the intra-cellular bundles of the primary nerve fibrills of the ganglion cell," and that "from our point of view, the vividly conspicuous components -- the spiral gyri (solenoids) of the pericellular -- should be taken not as accidental elongations for the purpose of a better approach to the surrounding tissue problem, which usually is done in the case of nerve fibers, but as special-purpose structures."

"Nor can we call accidental the "nodule-like intumescence," the varicose dilatations and similar formations at the ends of the telodendrons in general, and pericellulars in particular, as well as on the dendrites which have been puzzling the hystologists for a long time[5]. Our recent methods of dyeing the nerves enabled us to observe considerable quantities of excellently dyed pericellulars, particularly

the pericellulars of the so-called cells with spiral outgrowths. These remarkable and unusually beautiful formations, representing obvious natural solenoids, made us ponder many other problems of the physiology of the nerve stimulation, and the result is this particular work."

Further: "We thus get the following picture: The transmission of the stimulation from one neuron to another actually shows that we have something like two coils of an induction apparatus in the fibrillar mechanism of the ganglion cell, on the one hand, and the winding of the pericellular apparatus, on the other. The electric oscillation process occurring in one winding induces an isolation in the other winding. The pericellular bundles represent one of the windings, while the other receiving winding consists of intracellular fibrill bundles of the ganglion cell which, together with the adjacent perifibrillar matter, form the intracellular axon bundle. The best type of transmission is possible when both apparatuses are attuned to each other.

"The plates, nodules, etc., representing the capacity of the pericellulars, must play an important part of this tuning process; a similar process may possibly be played also by the windings of the nerve bundles comprising the pericellular apparatus."

The enormous significance of Academician A.V. Leontovich's work is that scientific explanation of the presence of electromagnetic induction of a biological origin in the human (as well as animal) nervous system. Without his previous caution and reservations, the scientist now states openly: "It should be borne in mind that the nerve, like any technical cable, represents a cylindrical condenser with its own self-induction. But as a live conductor, the nerve also has its differences. The latter consists in the fact that the electric wave is not only the outcome of some stimulated nerve molecule or an individual "nerve element," but, as it is commonly believed, it also stimulates its neighbor producing the same process in it. Inasmuch as the nerve is responsive also to other currents of suitable electric qualities, it would appear that under conditions of its natural exaltation it

can reveal a special process in relation to the electric pulses coming from other parts (of the nervous system--B.K.); we would like to emphasize this process with a special term. This interaction between the biologically structured molecules of the nerve elements and their own electric currents, usually coming from some farther point of the same nerve, is something in the nature of a mutual induction which calls for a special explanation. It is commonly known, that every biologically microscopic nerve element, which we shall call the "elementary nerve," when irritated by an outside electric current produces an electric stimulation current, an electro-bio-effect, and conversely, a natural stimulation of the nerve produces a potential difference which we will call the bio-electro-effect. These two processes are in a state of reversibility similar to that existing in the circular second tetanus established by Kisilev[6]; the second tetanus of the second muscular preparation is transmitted back to the nerve of the first, and stimulates the related first muscle; the current of the latter stimulates the second nerve and second muscle and that process continues for a long time. Earlier we referred to such an interaction of the electro-bio-effect as bio-induction. Of course, this bio-induction reaches its maximum in the terminal organs, the organs of transmission, and it is difficult to image that such a universal phenomenon as resonance is not characteristic of such a biological induction."

The concluding portion of his work, which A.V. Leontovich called the "Discussion" section, contains among other things important deductions and considerations for our theme: "The neuron works like an alternating current apparatus[7], and the nerve cell pericellular is part of the nerve structure with its own capacity and self-induction representing an ordinary part of a low alternating current mechanism and having a great deal in common with a radio receiver...In the summer of 1931, Romero Robles of Madrid, a student of Ramon-y-Cajal, published his interesting attempt to explain the operation of the nervous system on the basis of radio telephony. We note the particular stress laid in this connection on the dual system which we have been discussing whereby all the plates of the pericellular are divided into two separate systems (Kazhinskiy wrote about it in 1923)...

"The near-zero resistance of a stimulated nerve can be explained by the fact that the rows of nerve biomolecules ("elementary nerves" in our terms), when stimulated and in resonance, simultaneously develop electric forces...Under our theory, we are not concerned about the way the neurons are connected with one another; a break in the circuit is no obstacle to alternating current, and the connection is made possible by the pericellular, on the one hand, and by the elementary nerve turns duplicating the course of the neurofibrills in the intra-cellular baskets of ganglion cells, on the other. In radio engineering, such a device makes it possible to tune all the interfering oscillations our of an apparatus and tune it to the desired wave length as well as frequency transmission...It is quite probable, that the frequency of the basic waves of the nerve current is considerably higher than is usually believed on the basis of the experimental figures alone: according to formula (4), it is about 10^{10} power. If this were confirmed, then the experiment in nerve irritation would be found to reveal only the summary effect of several and even many waves. What is now experimentally taken as a changing wave frequency of the physiological process would then correspond only to the number of pulsations produced by the disrupted rhythm of several synchronized nerve mechanisms. This appears to point to a new field of ultra-microphysiology. This would also explain the possibility of the resonant transmission of phenomena of the sinusoidal oscillation type (that is not the relaxation type -- B.K.). The result is a mechanism similar to that of a radio transmitter: it transmits not only the waves but also their nuances. That would have been impossible if the resonance affected the waves themselves and not their high frequency components, as the resonant waves are of a sinusoidal nature...Remarkable as that figure may be when it is first encountered, we would still like to point out its following unusual characteristic: an electric wave with a frequency of 10^{10} per second is 3 centimeter long, that is almost as long as the already measured nerve stimulation wave (1.5-5 cm)[8]...The tonus is explained by the constant vibration of the live structural molecules of the elementary nerves; it is a high frequency vibration, something in the order of 10^{10} per

second. That is why no electric oscillations have yet been discovered in case of a tonus -- their frequency is too high even for such an apparatus as a cathode oscillograph (Italics mine -- B.K.). It is only the oscillation and pulsation resonance under some influence or other that produces electric waves, and these waves are made up of entire groups of basic electric oscillations, their pitch varying according to the state of stimulation; hence the nerve resistance at this particular moment (a situation similar to the one obtaining in radio engineering)...In view of the characteristic features of the internal structure of particular organ when its nerves are in the process of growth, there comes a moment in their development when the nerve telodendrons with their gyri and terminal platelike and nodule-like intumescenses form a substrate (a combination of components and parts -- B.K.) in which the electric charge produced by an electric ion dissociation, which accompanies every living process, by the creation of a Thompson oscillation circuit, that is a purely physical process of electric resonance...What we see in the nervous system is not an induction coil but a transformer of an entirely different and still little understood design; it is possible that it frequently works on a higher current ("avalanche-like stimulation growth," as it was called earlier--B.K.)."

Thus after many years of investigation, Academician A.V. Leontovich came to the indisputable conclusion that the neuron works on the principle of a Thompson oscillation circuit, revealing a growing belief in the inevitability of the emission of electromagnetic waves of a biological origin (the Thompson oscillation circuit: a vibrator).

Our Ranks Are Steadily Growing

We find more positive statements on this problem in later publications (in 1948) by Dr. B.V. Krayukhin, a student and follower of A.V. Leontovich's school and his chief collaborator in the experimental in the establishment of electromagnetic induction in the nerve elements of living organism; eventually (after A.V. Leontovich's death in 1943), he continued that work independently.

"A study of the literature and my own experiments," B.V. Krayukhin wrote (39, 40), "showed that living organisms and individual organs and tissues, when stimulated, create an electric field around themselves or emit electromagnetic waves which can be detected under certain experimental conditions. So far, the solution of this problem has been couched in very general terms. A detailed and thorough study of the electromagnetic radiation emitted by living organisms and their tissues will be made only when better radio-amplifying devices are available; the use of such devices will be just as important to the study of microphysiological phenomena as the microscope is to the study of the tissue structure."

It is important to point out that both A.V. Leontovich and B.V. Krayukhin look upon the physiology of nerve stimulation as a feature of a complex process whereby the chemical-exchange and electrophysiological processes are indissolubly connected. In their opinion, the pericellulars cannot be considered as merely mediator-organs[9] but, to a much larger extent, as unique apparatuses for the synaptic (contact--B.K.) transmission of an oscillatory stimulation current from one neuron to another. Thus in the opinion of A.V. Leontovich, the problem of current transmission from one neuron to another should be approached by both methods: the study of the mediator-type and electric transmission.

In general, there has been a growing interest in telepathy in recent years on the part of scientists. Dr. P.I. Gulyayev devoted a special section of his book[10] (1960) to the electromagnetic radiation from the brain in the course of thinking, stating that "The thought transference over a distance without the use of the sense organs is now an established fact, and it will probably soon be applied in practice. It appears that the carrier of the "telepathema" is something new to science -- a physical field produced by the brain." True, the author believes that that field is not of an electromagnetic nature.

The functional analogy of the neuron cells in the cortex with microgenerators and electromagnetic waves, advanced by V.M. Bekhterev in 1919, and P.P. Lazarev in 1920 and substantiated by the author of these lines in 1923, was later confirmed

by the German histomorphologist V. Kirsche [87]. Outlining the histological characteristics of the synaptic structure he had established, V. Kirsche compared their function to that of a microgenerator.

FOOTNOTES

Number		Page
1	(That report was read again by professor N.A. Ivantsov on 17 April 1924 in the Moscow House of Scientists.)	123
2	(Back in 1902, docent Ya.N. Zhuk conducted experiments in mental transmission of visual sensations in Kiev. He concentrated his gaze on a certain graphic image, while the test subject/unable to see that image/produced on paper at that moment any image that came to his mind. Eighty-six (51%) of the 169 tests were successful: the reproductions of the images were found to be the same/ Ya.N. Zhuk, The Transmission of Visual Sensations, Kiev, 1902/.)	129
3	(According to the theses developed by professor V.A. Poderni, the sound sensation of a "silvery ring" I perceived in 1919/in Tbilisi/ could have been transmitted to me from the brain of my dying friend at the time he was already losing consciousness but while his brain was still alive as was his receptor auditory organ with its elements of the nerve tract extending from the ear to the auditory center of the brain. The electromagnetic wave I perceived may therefore be called necrobiotic, that is moribund.)	130
4	(Ferromagnetism is a combination of magnetic phenomena and properties characteristic of a group of highly magnetic substances called ferromagnets and possessing such characteristics as the capacity of being highly magnetized even in weak magnetic fields, a high magnetic penetrability and the presence of magnetic hysteresis.)	132
5	(A.V. Leontovich defines the functions and purposes of these intumescences and dilatations as the functions and purposes of electric condensers in the nervous system.)	137
6	(Any kind of muscle irritation produces a stimulation: a shudder or a so-called tetanus. A shudder is a contraction of the muscle of very short duration, and a tetanus is a lengthy muscle contraction. A second tetanus is a contraction of the second muscle of similar duration produced by superposing on it a nerve from a separate neuro-muscular preparation of the first nerve which has been irritated by an outside stimulant.)	139
7	(Later Academician A.V. Leontovich adopted the definition of a "neuron as an apparatus of oscillatory current.")	139
8	(The average parameters of the oscillations of a neuron as a vibrator, as measured by A.V. Leontovich, are: λ = 21 cm; n = 10^{10} volt/sec; i = 10^{-15} amperes; L = 10^{-9} henry; C = 10^{-13} farad, R = 10^{10} ohm. Resistance R appears to be paradoxically insignificant, which is due to the development of an emf in the nerve-stimulation circuit, as an oscillation circuit.)	140

FOOTNOTES (Cont'd)

Number		Page
9	(A mediator means an intermediary; in this case "mediatory transmission" means a synaptic transmission of the nerve impulse from one neuron to another through a particular intermediate object, substance, etc., including a chemical property.)	142
10	(P.I. Gulyayev. Electric processes in the human cortex, Leningrad, 1960, pp. 103-105.)	142

CHAPTER VII

THE FRIENDS AND ENEMIES ABROAD

It seems to me important to touch on the differences in the contemporary outlook on the structure and functions of the elements of the nervous system. In this connection, the authors of physiological publications may be divided into two large groups: one of them firmly believing in the electrical transmission of neural impulses from one neuron to another, and the other, which is in the majority, subscribing to the belief in a "mediatory" transference and rejecting the electrical nature of these phenomena. The opinions of the scientists of the first group have already been quoted earlier. Those of the second group include such a scientist as J. Eccles [77], professor of psychology at the Canberra (Australia) university. Referring to his experimental data, this author points out when external (constant) tension is applied at two opposite points of the synaptic contact between two adjacent neural formations, thereby reducing the potential of the membrane dividing these adjacent formations, it produces a corresponding reduction of the so-called stimulating synaptic potential. A change of the potential sign in the membrane is accompanied by a change in the direction of the stimulating impulse in the synaptic potential. In other words, we get an experimental two-way conduction of the neural stimulant in the same conductor-nerve. The author believes that while this electric transmission hypothesis offers no explanation to this phenomenon, it can easily be explained by a chemical transmission hypothesis. Further, in his opinion, the polarity of the synaptic membrane, produced under the effect of inhibition processes in the nerves, cannot be explained by an electric transmission hypothesis. When the potential of the membrane, through which the inhibitory synaptic potential passes, is reduced under the effect of an external current, it not only produces a corresponding reduction in the synaptic potential in general but may also change the sign of that potential and the direction of the inhibitory impulse in the synaptic potential with it. Or, which is the same, the result may be a two-way conduction of neural inhibition. And in this case, too, according to that author,

the electric transmission hypothesis fails to provide any explanation. Proving the chemical nature of the mechanism governing the synaptic passage of the impulses, J. Eccles concludes that "the electric transmission hypothesis is completely unsuitable."

We believe, however, that S.M. Sverdlov who wrote the introduction to the Russian edition of this book is right when he claims (countering J. Eccles) that "the electrical and chemical hypotheses apparently should not be considered as mutually exclusive since, in the final analysis, the 'chemical aspect' manifests itself 'electrically'." We will merely add that in these processes the "electrical aspect" also manifests itself "chemically." In this respect we are entirely in agreement with the viewpoint held by A.V. Leontovich and his school. The point is that there is a certain "apartness" between the biological and electric processes in the nerves. Goth and Burch [25] proved experimentally that degenerating nerves do not show any electric oscillations even if they still produce a physiological effect. In the process of regeneration such nerves produce a reverse picture: there is a certain phase in which the electric effect is present and the physiological effect is still absent. These facts, in A.V. Leontovich's opinion, provide sufficient ground for disregarding what we call a two-way passage of the nerve stimulant (or inhibition), as well as the objection to the "electric transmission hypothesis." For the results of J. Eccles' experiments had been produced only by the application of a current from the outside. Nor should we forget the contradiction between the experimentally achieved possibility of a two-way passage of the neural impulse and the polarity of that process in nature, that is the polarity of a live nerve in general. This polarity is apparent from the well-known scientific fact that an effective accretion of the nerves of the sensitive and motor tracts is impossible, as well as from the separate existence of these tracts. Although the neural impulse in each of these tracts (if they are in parallel) travels in opposite directions (centrifugally in one, and centripetally in the other), it is always unipolar. Finally, we have the following categorical statement by A.V. Leontovich

[47] on the subject: "We are personally inclined to what seems to us an indisputable point of view according to which the molecular-chemical and electrical processes in the nerve are closely associated with each other, just as the famous Robert Myer had visualized it. The important point, however, is that the passage of the stimulant through the pericellular apparatus (and through the synaptic contact -- B.K.), and its anatomic gap between the system of one neuron and that of another, is conceivable only from one point of view, namely that this jump in the area of the pericellular apparatus is facilitated by the electric oscillation occuring in the pericellular apparatus, on the one hand, and the ganglion cell body, on the other."

Citing these contradictions between the views of J. Eccles and those of the other scientists, we should also emphasize the conclusions from the mentioned work of that author (published in 1957) which are in agreement with both our work published in 1923 [36] on the existence of a closed oscillation circuit in the nervous system, and V.A. Leontovich's work [47], published in 1933, on the neuron as an oscillating current apparatus. J. Eccles graphically represents the electric characteristics of the membrane surfaces of a motor neuron in the form of several equivalent schemes of a closed oscillation circuit. In it he points our the arithmetic mean value of the membrane potential, capacity and resistance. The only thing he did not indicate is the self-induction value, although it is clear that the self-induction of a neuron axon similar to the self-induction of a simple cylindrical conductor, as mentioned by Ferraris [71], is also an integral component of the oscillation process.

In 1925 there appeared the first press reports on the work of the Italian scientist F. Cazzamali [37], professor of neurology and psychiatry at the Milan (Italy) university which had begun in 1924 (that is two years after we had started our experiments in V.L. Durov's laboratory in Moscow); using a Faraday cage, Cazzamali investigated "telepsychic phenomena and brain emissions" or, as it was later found, visceral electromagnetic radiation from the human organism.

The screening chamber used in Cazzamali's experiments (Fig. 18) looked like a spacious cabin with its walls, floor and ceiling made of boards, and the outside covered with lead-plated roofing tin 0.5 to 1.5 mm thick.

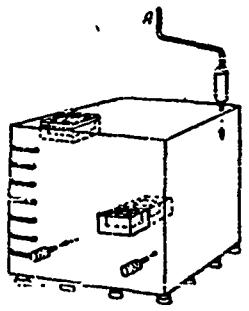

Fig. 18. F. Cazzamali's screening chamber:

A - the tube and filter feeding fresh air into the chamber

A check on the screening characteristics of this chamber produced positive results even without a ground wire: the radio receiver inside it could not intercept any signals from the transmitter working outside. Four radio receivers designed to intercept 1 to 4,000-meter wavelengths were used in the experiment. Receiver No. 1, used in the initial stage for 300-4,000-meter waves, was equipped with an antennal loop for short waves and antenna coils for long waves. It had four high-frequency tubes and a detector consisting of two low-frequency tubes. Receiver No. 2, introduced later, had a crystal detector (galena and pyrite) and a wire antenna covering the entire length of the chamber (2 meters). This device, capable of intercepting still shorter waves, was equipped with a low-frequency amplifier. Receiver No. 3 with a double heterodyne circuit was used to investigate the waves on a 50-100 meter band and designed to include an "adjacent" wavelength in order to damp the possible oscillations produced by (interference from) the experimenter inside the chamber. Finally, receiver No. 4 with a round antenna loop (300 mm in diameter) was used for intercepting still shorter wavelength, from 1 to 10 meters.

The sounds coming through the telephone receiver, following the addition of the heterodyne device for the four-meter wave, were of an unusual timbre and nature.

The people selected as test subjects were nervous-disease patients whose mental activity could be stimulated to any degree by hypnosis. Epileptics and people suffering from hysteria were found to be the best percipients: hallucinations of a visual nature could be easily induced in them by hypnotism. Sitting in the chamber with the test subject, the experimenter, who was also a hypnotizer, recorded all the changes in the sounds heard through the receiver microphone.

The most interesting results were obtained when receiver No. 4 was used. Here is a translation of what Prof. Cazzamali recorded: "The receiver No. 4 antenna was usually directed toward the test subject. He frequently fell into an autohypnotic trance as soon as I invited him to sit in the chair. The noises I then heard in the telephone were similar to radiotelephone signals. The latter were interrupted as soon as the subject woke up, and continued when he fell into a trance again. The stimulation of hallucinatory visions in the hypnotized test subject was followed by an intensification of the noises; these acquired a specific characteristic in keeping with the changing intensity of the induced emotions. Some of the sounds were so characteristic that they were quite different from the ordinary ones produced by the rhythmic operation of the storage battery. These sounds were intensified whenever the subject had a spontaneous hallucination, as an acoustic hallucination, for example. The sounds diminished and faded out altogether as the subject calmed down and woke up. When the subject's emotions (hallucinatory visions in a deep trance) were intensified, the whistles and modulated tones heard in the telephone resembled the sounds made by a violin equipped with a mute."

Prof. Cazzamali also made a study of quite normal people by stimulating them, without hypnosis, to creative imagination, for example. The intensified cerebral activity of these subjects also produced very definite sounds in the microphone. But the experiments with people in a state of depression were not accompanied by any distinctive sounds in the telephone. According to Cazzamali, his experiments

prove that the radio receiver intercepted the sound oscillations emitted by the nerve centers of the human brain.

Prof. Cazzamali's work was commented on in the soviet and foreign press by scientists and practitioners in the fields of neurology, psychiatry and radio communication. There were also criticisms casting doubt on the Italian's statement to the effect that he had succeeded in recording the radiation from the cerebral nerve centers.

The work of the Spanish medical student E.R. Robles [56] is a matter of particular interest. He himself refers to his idea as a "working hypothesis." Like ourselves, E.R. Robles believes that the centrifugal fibers found in the receptor sense organs play an important part in conducting the perceptions from the same sense organs (vision, olfaction, acoustic) in the brain, in addition to the centripetal fibers of the neuron tract (which conducts the sensation from the periphery to the center).

I consider it appropriate to recall that, in my opinion, these centrifugal fibers are part of the second half of the closed Thomson oscillation circuit in the nerves (the first half is the centripetal tract) which plays the part of a reverse communication in this circuit. Herein lies the essential difference between Robles' views and our own.

Assuming that these centrifugal fibers are the branching ends of a conductor nerve-filum leading from somewhere to the receptor sense organ, Robles sees it as the second end area of the nerve. But between these two ends (of the centripetal and centrifugal nerves) he assumes the existence of a third, and terminal, element in the form of a branchy end of a third nerve filum, and builds his hypothesis to explain the possible existence of an electric connection between these three nerve endings. He uses the analogy with the function of a triode radio tube to explain that electric connection.

E.R. Robles suggests that every stimulation of the receptor organ, when a particular sensation is sent to the brain, actually amounts to the establishment

of an electric connection between the three nerve ends in the receptor. Consequently, every receptor apparatus has three different nerve elements: 1) the fibers of the centrifugal nerve tract with one type of charge; 2) the fibers of the centripetal tract with an opposite charge; 3) the fibers of the sensation-receiving and controlling (guiding) nerve element which is occasionally represented by two cells: a receiving (the receptor itself) and transmitting cell. The author compares the function of such an apparatus to that of a triode tube developed by Lee de Forest.

Developing his analogy further, E.R. Robles compares the nerve cell, as a receiving element, to an antenna tuned to a certain wavelength. The second (controlling) cell, which is electrically connected with the first, he compares to the grid of a triode tube connected to the antenna. Such bipolar cells actually exist in the eye (retina), in the tiny olfactory cell glomera of the olfactory organ, in the nerve ends surrounding the epithelial (capillary) cells of the acoustic organ, etc. and, finally, in the spinal cord ganglions.

E.R. Robles considers the muscles (muscle energy) as the source of nervous energy. Supplementing his analogy of the nerve elements, as components of a radio tube, with an analogy of the muscle functions, as energy suppliers, he produces a complete diagram of the "radio station" in the nervous system of a living organism.

Reading these analogies, I was glad to realize that they support, supplement and develop my assumptions, made back in 1919, about the detecting, amplifying and generating role of certain nerve elements which I compared to triode radio tubes. Thus in addition to the Thomson closed oscillation circuit and the open vibrator in the human nervous system, the future researchers will have one more starting point for their investigations in this field: the triode radio tube. The rightful claim of this assumption is supported by the latest achievements in radio engineering.

At the time these lines were written (in 1960), a new device was developed in radio engineering, the "solyon"; appropriately designed, that device can serve

as a radio tube and play both an amplifying and detecting or generating role. The remarkable feature of this device is that its physical structure is similar to that of a live cell. The electric processes in it occur not in metal parts or conductors but in a liquid medium, a salt solution, similar to the electrolyte of the nerve substance. Here are some of the characteristic features of that device.

The "solyon" is similar to an electrolytic cell: it also has two electrodes immersed in electrolyte. But between them is a porous partition through which the ions pass on their way from one electrode to the other. The movement of the ion stream between the two electrodes can be affected by numerous causes. One of them may be an increase in the temperature of the electrolytic solution. When the solution is heated and a temperature difference produced between the heated portion of the electrolyte (on one side of the partition, for example) and the unheated part (on the other side of the partition), the current changes.

The change in the potential of the porous partition produces an intensified change in the current, and "solyon" functions as an ordinary amplifying radio tube. The partition functions as a tube grid: it accelerates or slows the movement of the ions. We can see that this device can be used as a good illustration in the analogy between its function and that of the cell generators in the central nervous system.

I was encouraged by yet another thought. E.R. Robles' work was submitted for publication (in 1931) by Prof. R. Hortega, a pupil and disciple of Ramon-y-Cajal, the investigator into the histology of nerves. This shows that Hortega approved Robles' work. This made me confident that the Spanish scientist would probably have approved my working hypothesis too, if he had read it.

As for Robles' belief that the muscles are the source of nervous energy, I think it is less valid than Acad. V.M. Bekhterev's opinion, supported by Acad. A.V. Leontovich, that the source of nervous energy for each neuron are the Nissl granules in the ganglion cell soma.

Interesting Observations In Canada

In 1959 V. Penfield, foreign member of the USSR Academy of Sciences and professor of neurology and neurosurgery at the Montreal (Canada) university, published [83] some conclusions from his 23-years' investigations of human psychic reactions to the irritation of the cortex produced by applying an electrode to it, both with and without a current. These investigations included over 1,000 cases of trepanation under local anesthetics, with the patient remaining fully conscious. It may be said that these efforts resulted in the investigation of practically every region of the cortex.

Thus an electrode sending one-volt pulses to the cortex -- with a frequency of 60 oscillations per second and a pulse duration of 2 m/sec--produces a usual optic sensation when held close to the optic region of the cortex. The patient sees light and distinguishes colors and shades as they move by him and assume various forms. The same electrode, applied to the cortical acoustic region, compels the patient "to hear" sounds, hissing or knocks. An irritation of the central gyrus produces a "creepy" sensation and a false sense of motion.

Worthy of attention is Prof. Penfield's belief that when the cortical region of the optic center is stimulated by a current, the patient receives light sensations but does not perceive the full cinematographic picture of such sensations. Similarly, an irritation of the cortical matter in the region of the acoustic center produces a sensation of ringing, buzzing, hissing and rapping in the ears but never the sound of voice or speech. In other words, an element of optic, auditory or tactile sensitivity is activated each time, but not the recollection of past events or experiences.

But there is an area on the cortical surface, covering part of both temporal lobes, which is known as the interpretive region; an electric irritation of that region "may call up a number of past experiences." Until recently the neuropathologists paid little attention to these cortical regions assuming that they had little connection with the human psyche. But it may now be considered as an

established fact that "an electric irritation of this particular region occasionally produces a psychic state which may be divided into two types of reaction: reactions of reproducing past experiences and interpretational reactions."

Following is a series of experiments resulting in a psychic reaction of reproducing past experience. When a charge electrode was applied to his temporal lobe, patient S.B. said: "There was a piano there, and someone played it. You know, I heard a melody." When the cortex was irritated again at about the same spot, without the patient knowing it, he said: "Someone is talking to someone else and mentioned my name but I could not quite hear it... It was like in a dream." When the cortex was irritated once more at the same sport, without the patient knowing it, he said quietly: "Yes, Oh Mary, Oh Mary, someone is singing that song." In a fourth attempt to irritate that part of the cortex, the patient said that it was "a commercial song of a certain radio program." After that (the fifth time), the electrode was applied 40 mm closer to the front part of the upper temporal gyrus, and the patient said: "Something is recalling memories. I see the Seven Up bottling company... the Harrison Bakery." The experimenter believes that the patient probably "saw" two advertizing posters of a Montreal business firm. After that the surgeon warned the patient that an electrode would again be applied to the brain. The point is that the patient himself has no way of knowing when the electrode is applied to his brain, if he is not told so, as the hard shell of the cortex is not sensitive to mechanical irritation produced by touching a solid object. Thus when the surgeon later applied the electrode again, without comment and asked the patient what he felt, he replied "nothing at all" (that is he felt no sensation).

When a charge electrode was applied to the brain of a woman patient, D.F., she "heard" an orchestra playing a certain melody. But the music of the same "orchestra was heard" again (in the patient's sensation) when the electrode was applied once more. Moreover, at the request of the surgeon, the patient began to sing the melody she "was hearing," as if following the orchestra -- it turned out

to be a popular song. The surgeon repeated the irritation several times with the patient invariably recalling the sounds of the same song each time. Every time the song began with the same measure and continued in the usual tempo. All the surgeon's attempts to confuse the patient's performance of the song were unsuccessful. She was under the impression that a phonograph was playing in the operating room, and kept assuring other people about it even several days after the operation.

A third patient, a boy named R.V., "heard" his mother talking on the telephone when an electrode was applied to his right temporal lobe. When the irritation was repeated (without the patient's knowing it), he again "heard" his mother's telephone conversation. This irritation was repeated a third time, and the boy said: "My mother is saying to my brother that he had put his overcoat on backwards. I hear both of them." But when the surgeon asked the boy whether such a conversation had actually taken place, he replied: "Oh, yes, shortly before I arrived here." Asked whether he felt like in a dream, the boy said: "No, but I seem to be confused."

A fourth patient, Zh.T., exclaimed in surprise as the electrode was applied to his temporal lobe: "Doctor, doctor, I hear people laughing... my friends from South Africa." Asked why he was surprised, the patient replied that he felt as if he himself was laughing with his cousins Bessie and Anna, even though he realized that at that moment (when he was supposed to be laughing) he was on the operating table in Montreal.

Outlining the other (interpretive) results of a similar irritation of the temporal lobe with an electrode, Prof. V. Penfield proves that in such cases the patient reasons and explains (interprets) what he "sees," "hears" or thinks during the electric irritation. The patient may claim, for example, that he is experiencing something familiar, something he had allegedly seen or heard. At the same time he realizes that his present state or sensation is unreal. Occasionally a patient is gripped with fear and even panic without any understandable reason.

Impressed by the information appearing in the press about the steady development of mental telepathy, the English physicist O. Lodge stated in 1925: "I can visualize the inevitable future possibility of thought transference from one brain to another without the aid of such vibrations as we are now using in technical radio communication" [2].

Prof. A. Jurno, head of the electrophysiological laboratory of the medical faculty at the Paris university, succeeded (in 1957) in developing a hearing aid in the form of an artificial ear for a totally deaf man whose membranes had been destroyed in both ears. He designed a miniature induction coil (25 mm long and very thin) with two windings of thin silver wire around a steel core. The coil was enclosed in a sealed plastic shell. One of the windings was connected to the undamaged fibers of the auditory nerve, and the coil inserted in the air canal of the ear (behind the temporal bone) and left there until the auditory nerve healed at the contact points. Tests were made three days after that operation. The sounds, signals and words pronounced by the experimenter were intercepted by a microphone connected to an amplifier whose outlet was connected to the second winding of the induction coil (in the patient's ear). The patient began to perceive light irritations and distinguish separate words although, as he said, they were muffled by interfering whistling noises. After several months of training with the use of a magnetic sound recorder, the patient was able to understand 75% of what he heard even though the sounds he heard were (in his opinion) different from normal speech. It was found, however, that he began to distinguish sound vibrations above and below the range normal for the human ear. The first experiment was followed by successful operations on other deaf patients.

Thousands of Kilometers Away

Similar efforts have been pursued abroad, especially in the U.S., on a considerable scale since 1957, but it appears that the main reason for that is that the results might be of great military significance. The U.S. Army, Navy and Airforce departments began to evince quite an interest in such experiments. If in the past

several years the necessity for such research was still doubted, the collection of numerous indisputable facts of telepathy that attracted the close attention of a number of noted scientists (P. Jordan, Nobel prize winner, B. Hofmann of the famous Einstein laboratory at Princeton, A. Bergson, etc.) made the erstwhile skeptics considerably more restrained in their objections.

Beginning with 1958, a number of large and well-known American electric and electronic firms opened their own research laboratories for the study of telepathy (Westinghouse in Friendship, Md.; General Electric in Schenectady; Bell Telephone in Boston, Mass.). These are the major projects to be developed by the mentioned laboratories: the establishment of the methods of telepathic transmissions; the development of devices for recording and reproducing telepathic signals; the determination of the amplitude and frequency of the telepathic transmission signals, etc.

In a memorandum to former President Eisenhower, the Rand Corporation suggested the utilization of the latest possibilities in the field of telepathy for the purpose of obtaining information by the submarines particularly those under water beyond the Polar Circle (where ordinary radio communication is subject to special interference).

Acting on a government assignment in 1958, the Westinghouse special laboratory of Friendship carried out a lengthy experiment in thought transference (visual perceptions) from one person on land to another in the submarine Nautilus which was submerged 2,000 kilometers away from the first person. U.S. Naval and Air Force personnel and transport facilities were involved in that experiment.

The following details are known from the reports on that experiment. Col. B. Bovers, director of the biological department of the Air Force's research institute, was in charge of the tests at the Friendship laboratory. The experiments began on 25 July 1958 and continued daily for 16 days. Operator Smith, a student of Duke University in Durham (North Carolina) was confined to one of the laboratory buildings all through the experiments. He acted as an inductor, a transmitter of visual sensations. Twice a day, at a certain hour, the inductor started an automatic

machine controlled by a timing device; 1,000 cards of the Zener system[1] were shuffled in the machine's revolving drum. Five cards would drop out of the drum at one-minute intervals. The inductor would pick up each card (in the order it came out), concentrate on it trying to memorize the image on it, and at the same time draw the figure of the card on a sheet of paper. On the same sheet he would also draw the figure appearing on each of the following cards. The result was a sheet of paper with five figures on it appearing in a certain sequence. Smith would then seal the paper in an envelope, write down the time of the experiment, sign the envelope and turn it over to Col. Bowers who would lock it in a safe.

Something similar would take place at the same time on board of atomic submarine Nautilus which was sailing in the Atlantic (2,000 kilometers away). There, an operator-percipient (or an indicator, according to our theory), a navy lieutenant by the name of Jones, was isolated in one of the state rooms. His presence aboard the Nautilus was surrounded with secrecy.

He was not seen by any member of the Nautilus crew from the time he boarded the submarine from the pier until he was locked in a separate room, with the exception of one sailor who was at his service, and the captain of the Nautilus, Andersen (who visited him twice a day). During those 16 days Jones did not get any information "through volition." Every day (twice a day, at a specified time coinciding with the work of inductor Smith at Friendship) he would draw on a sheet of paper, in whatever sequence he chose, any of the following figures: a circle, a square, a cross, a star or three parallel wavy lines. The result would be a group of five figures appearing on the sheet of paper in a certain succession. Jones would seal the paper in an envelope and hand it to captain Andersen as he came into his room. The latter would indicate the date and hour of the experiment on the envelope, sign it and take it to his cabin and lock it in a safe.

When the Nautilus returned from her cruise to Groton, percipient Jones and his envelopes were immediately sent by car, under escort, to the nearest military airfield, flown to Friendship airport and from there taken by car to Col. Bowers'

laboratory. The latter compared the contents of the two groups of envelopes (sealed by the percipient and inductor), and established that the figures in them were identical in over 70% of the cases. Percipient Jones had "guessed" three-fourths of the images in inductor Smith's brain.

The U.S. Navy and Air Force have thus received experimental confirmation of the fact that communication between two people, separated by long distances, can be carried out through water, over the air and across metal barriers by means of cerebral radiation in the course of thinking, and without conventional communication facilities.

One important feature of the above-described experiment is worthy of attention. The electromagnetic waves accompanying the thought-formation process (visual perceptions) in the inductor's brain reached the cells of the indicator's cortex after having travelled a long distance, not only in the air and through water but also through the metal hull of the submarine. This would justify the following conclusions: 1) these electromagnetic waves were propagated spheroidally, not in a narrow directed beam; 2) these waves penetrated through the submarine hull which did not block them, that is it did not serve as a "Faraday cage."

We know, for example, that the radio receiver in the marine laboratory of the Soviet scientific-research ship Vityaz' were able to intercept the electric waves emitted in the water by the torpedo fish.[2] But the radio receivers in the submarines do not intercept these waves. This prompts the conclusion that some electromagnetic waves of a biological origin possess yet another, still unknown, characteristic that distinguishes them from conventional radio waves. It is possible that our ignorance of that particular characteristic impedes the further development of research work in that field. Indeed, several years have passed since those American experiments involving the Nautilus, but nothing is as yet known about any new achievements in this direction.

Some Results And Prospects

Unfolding before our eyes is an exciting prospect of cognition and the mastery of a new and powerful weapon of scientific and technical progress, the method of biological radio communication.

It matters little that much is still unclear in this field and a great deal is still subject to thorough scientific research (after all, everything that is new and unexplored reaches our knowledge by that road!). A beginning has already been made, but the fundamental search continues. We have a number of cogent experimental works produced by V.M. Bekhterev, P.P. Lazarev, A.V. Leontovich, B.V. Krayukhin, V.A. Poderni, L.L. Vasil'yev, S.Ya. Turlygin, T.V. Gurshteyn, V.L. Durov and others. These works provide an excellent basis for further theoretical development and generalizations.

The most important results already achieved in this connection is, first of all, the discovery of nerve elements resembling paired condenser armatures and solenoid windings. The existence in the nervous system of oscillatory bioelectric currents functioning on the principle of a condenser and solenoid in a Thomson oscillation circuit has been experimentally proved. The induction effect of these currents within the organism has been established. A foundation has been laid for the theory of bio-electromagnetic wave generation by the central nervous system in the process of thinking.

Numerous experimental observations of the life and behavior of man, animals, birds and insects serve to confirm the existence of bio-electromagnetic waves and bio-radiation emissions originating in the nervous system and other sources, biological vibrators. Elements of biological radio communication between people (in the process of thinking) as well as mental suggestion to animals by man have been established by experiments.

The emerging theoretical foundation of bio-radiation communication among people encourage us to look into the possibility of the further development of the existing teaching methods on a higher level. The teaching elements involved in the

formation of human consciousness in children and adolescents must be enriched with a new progressive element, the application of the mental suggestion method. The word, speech, visible and audible signals, a picture, a book, physical models and objects could be supplemented by a direct mental transference of appropriate image concepts, sensations and feelings.

In other words, we must apply a systematic and organized bio-radiation effect (according to a definite program) in the future by making use of the "telepathema" emitted from the brain of the educator and teacher and beamed to the brain and psyche of the student. This, of course, will require that the program of disciplines involved in the training of teachers include not only psychology but also the practical study of mental suggestion methods. New physical devices may and should eventually be developed to help the educator and teacher carry out the mental transmission of the necessary concepts and ideas.

One of the most serious difficulties of the nascent science of biological radio communication is the lack of instruments capable of recording the bio-radiation wave parameters corresponding to the thinking process. The difficulty lies in the ultramicroscopic size of the wave which cannot be studied at the present level of radio instrumentation. But this difficulty is not necessarily insurmountable. It will surely be surmounted by the future achievements in soviet radio electronics.

As Acad. I.E. Tamm, Nobel Prize winner, aptly put it, "the present situation in biological science is similar to that in physics before the discovery of uranium fission and the methods of controlling atomic energy. I believe that the leading role of natural science will in the relatively near future be shifted from physics to biology. Biology will in the future, as physics does now, create new important branches of technology which will, to some extent, determine its further development."

These words apply also to the nascent branch of "biological radio communication." It is in this field that biology will supply us with a number of new apparatuses which are in principle identical with some of the live nerve "apparatuses"

if, by making a thorough study of the latter, we determine their exact role in "biological radio communication."

Let us take a look at the possibilities in this direction. Closely associated with the development of sophisticated instruments and conductors possessing superconductivity, when cooled to a temperature close to absolute zero, is the idea advanced by the soviet scientists about quantum radio engineering -- the so-called molecular generators producing highly uniform electric oscillations over a lengthy period of their utilization. Another and no less important achievement in this field is the creation of molecular amplifiers capable of magnifying the sensitivity of the apparatus many times, and reducing the noises which have in the past distorted the reception and shortened the effective distances of the radio communication facilities. The possibility of applying the ideas of molecular generators and amplifiers to the study of subtle physical phenomena accompanying the functions of the brain in the process of thinking and thought transmission, and the perception of a "telepathema" from a distance, is far from ruled out.

In summing up the ideas outlined in this writing, I feel like offering a word of advice, or making an appeal, to the future readers of this book. May the most energetic among you, especially our curious youths, the young teachers and college and secondary school students, be impressed with the urgency and imbued with the persistent desire to make a thorough study of the physiology of nerves from the standpoint of "biological radio communication."

Tackle the still unresolved problems in this field boldly and fearlessly, develop new hypotheses and new methods for the successful solution of the mysteries of biological radio communication.

Show no fear, build analogies, search, argue and experiment!

Just as the investigations into the internal world of the atom discovered its mighty energy and placed it in the service man, so the full comprehension of the thinking patterns will help us uncover the greatest secret of living matter, its ability to think, and still further enhance the power of reason over the blind forces of nature.

FOOTNOTES

Number		Page
1	(The Zener system cards are especially designed for experiments in telepathy. One of the following five figures appears on one side of each card: a circle, a square, a cross, a star or three parallel wavy lines. The colored "shirt" appearing on the other side was the same on every card of the deck.)	159
2	(There are 7 families of electric fishes, including 500 species, but only 20 of them have been studied. It is known that the torpedo fish /or skate fish/ can produce a 60 kw discharge. The electric fish controls its discharges by a neural impulse. It is capable of intercepting external electric energy from a distance by the use of its special organs, electroreceptors.)	160

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